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AIRDOS-EPA: A Computerized Methodology for Estimating Environmental Concentrations and Dose to Man from Airborne Releases of Radionuclides

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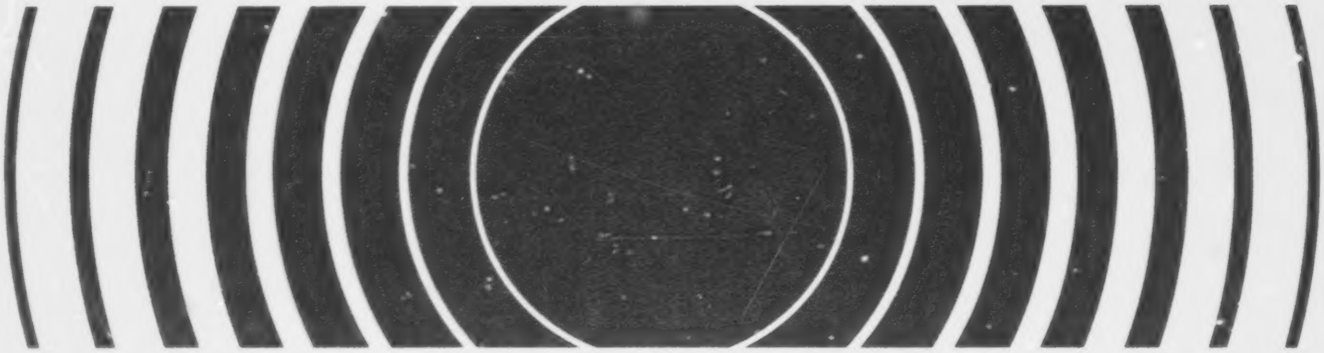

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The code may be run to estimate the highest annual individual dose or the annual population dose. For either option, output tables summarize doses by nuclide, exposure mode, and organ. Also, for either a square or circular grid option, ground concentrations of radionuclides and intake rates by man are tabulated for each environmenal location. Working level exposures are also calculated and tabulated for inhalation of ^{222}Rn short-lived progeny. Note: Corrections to the text and computer code through December 1979 have been incorporated into this printing.

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ABSTRACT

The AIRDOS-EPA computer code is a methodology, designed for use on IBM-360 computers, that estimates radionuclide concentrations in air; rates of deposition on ground surfaces; ground surface concentrations; intake rates via inhalation of air and ingestion of meat, milk, and fresh vegetables; and radiation doses to man from airborne releases of radionuclides. This report describes the atmospheric and terrestrial transport models used in the code, their computer implementation, and the applicability of the code to the assessment of radiological impacts. A listing of the code and a demonstration run of the code are presented in the appendices.

A modified Gaussian plume equation is used to estimate both horizontal and vertical dispersion of as many as 36 radionuclides released from one to six stacks or area sources. Radionuclide concentrations in meat, milk, and fresh produce consumed by man are estimated by coupling the output of the atmospheric transport models with the U.S. Nuclear Regulatory Commission, Regulatory Guide 1.109 terrestrial food chain models. Dose conversion factors are input to the code, and doses to man at each distance and direction specified are estimated for total body, red marrow, lungs, endosteal cells, stomach wall, lower large intestine wall, thyroid, liver, kidneys, testes, and ovaries through the following exposure modes: (1) immersion in air containing radionuclides, (2) exposure to ground surfaces contaminated by deposited radionuclides, (3) immersion in contaminated water, (4) inhalation of radionuclides in air, and (5) ingestion of food produced in the area.

The code may be run to estimate highest annual individual dose in the area or annual population dose. For either option, output tables summarize doses by nuclide, exposure mode, and organ. Also, for either a square or circular grid option, ground concentrations of radionuclides and intake rates by man are tabulated for each environmental location. Working level exposures are also calculated and tabulated for inhalation of ^{222}Rn short-lived progeny. Run time is less than 5 min on the IBM 360/91, and the core requirement is 650 K (kilocore).

1. INTRODUCTION

The AIRDOS-EPA computer code was developed at Oak Ridge National Laboratory (ORNL) to be used by the U.S. Environmental Protection Agency (EPA) as part of a methodology to evaluate health risks to man from atmospheric radionuclide releases. This report describes the final version of an interim methodology outlined under Task I of Interagency Agreement No. EPA-78-D-X0394 between ORNL and the EPA. The models and parameters described in AIRDOS-EPA will be reviewed and reevaluated under Task II of this interagency agreement.

The code is a modified version of AIRDOS-II (Moore, 1977), which has been used by the Environmental Sciences Division (ESD) and the Health and Safety Research Division (HASRD) of ORNL for several years to assess radiological impacts of routine operations of nuclear facilities. Both point sources and uniform area sources of atmospheric releases of radionuclides can be evaluated by AIRDOS-EPA, which estimates (1) concentrations in air, (2) rates of deposition on ground surfaces, (3) ground surface concentrations, (4) intake rates by man via food ingestion and air inhalation, and (5) radiation doses received by man.

As many as 36 radionuclides released from one to six stacks or area sources can be handled in a single computer run. Annual-average meteorological data for the area surrounding a nuclear facility may be supplied as input to the code, which then estimates air and ground concentrations and intake rates by man for each radionuclide at various distances and directions from the release point or the center of an area source. From these values, doses to man at each distance and direction specified are estimated for total body, red marrow, lungs, endosteal cells, stomach wall, lower large intestine wall, thyroid, liver, kidneys, testes, and ovaries through each of five exposure modes. These modes are (1) immersion in air containing radionuclides, (2) exposure to ground surfaces contaminated by deposited radionuclides, (3) immersion in contaminated water, (4) inhalation of radionuclides in air, and (5) ingestion of food produced in the area. The dose calculations are made with the use of dose conversion factors supplied as input data for each radionuclide, exposure mode, and reference organ or tissue.

At the option of the user, the area surrounding the source may be subdivided either with a circular or a square grid. For the circular option, as many as 20 distances may be specified for each of 16 compass directions. Each distance represents the midpoint of a sector. The square option employs a 20 by 20 grid with the source at the center. The grid size is specified by the user.

The code may be run to estimate either the highest annual individual dose in the area or the annual population dose. For either of these options, tables are provided as output which summarize doses in several ways — by nuclide, exposure mode, and organ. Also, for either option selected, ground concentrations of radionuclides and intake rates by man are tabulated for each specified environmental location. In addition, working level exposures are calculated and tabulated for inhalation of ^{222}Rn and its short-lived progeny.

Section 2 of this report discusses the atmospheric and terrestrial transport of released radionuclides and the methods used for calculating the resultant dose to man from these radionuclides. Section 3 details the atmospheric and terrestrial transport models used in the code. Section 4 describes the input data requirements for the various user options. Section 5 lists terrestrial transport input parameters used in a demonstration run of the code. The methods used to determine the values presented are briefly discussed, and special problems in the determination of parameter values are identified. A listing of the code and a demonstration run of the code are presented in Appendix A and B, respectively.

2. APPLICABILITY OF THE COMPUTER CODE FOR ATMOSPHERIC DISPERSION CALCULATIONS AND RADIOLOGICAL ASSESSMENTS

Release rates (in curies per year) to the atmosphere from each point or area source are known collectively as the source term. The plume containing radionuclides is dispersed both horizontally and vertically as it is blown downwind. The code estimates the annual-average concentration (picocuries per cubic centimeter) of each radionuclide in the source term in air at ground level as a function of direction and distance from the source; annual-average frequencies of wind direction, wind speed, and atmospheric stability category are employed as input data.

Radionuclides in the form of particulates or reactive gases deposit on ground or water surfaces through scavenging processes, which primarily consist of washout by rainfall, and through dry deposition processes. The code estimates the deposition rate for each radionuclide in units of picocuries per square centimeter per second for each location for which estimated air concentrations are calculated.

Both the air concentrations and the ground deposition rates are average values in the crosswind direction over each of sixteen 22.5° sectors emanating from the source. For the square grid option, the 22.5° sector-averaged values in a circular coordinate system are converted to values in rectangular coordinates. Sector-averaging is a realistic treatment for assessments using average meteorological data, but the code does provide an option to the user to compute plume centerline values if desired for a special application. Plume centerline values are several times higher than sector-averaged values.

The average concentration of a radionuclide in air at ground level at an environmental location is used to estimate the external dose from gamma radiation to an individual living at that location for an entire year as a result of his immersion in an assumed semi-infinite cloud of that concentration. A conversion factor for immersion gamma dose at the skin surface is supplied as input data for each radionuclide. These values are multiplied by correction factors, also supplied as input, to estimate the external gamma dose contributions for each radionuclide to other reference organs.

The air concentration at each location is also used to estimate internal dose via inhalation. Input dose conversion factors (rem per microcurie) for each radionuclide and organ include contributions from radioactive daughters growing in after human intake, and, when multiplied by the intake for one year (microcuries), result in values for a dose commitment resulting from that annual intake.

Rates of deposition on ground surfaces are employed to estimate external doses resulting from gamma radiation emanating from contaminated ground. A period of time, supplied as input, is allowed for surface buildup. Doses are estimated for a point 1 m above an infinite plane with the calculated concentration in units of picocuries per square centimeter. Dose conversion is handled in the same way as for air immersion doses.

The external dose from water immersion is calculated as resulting only from immersion in water subjected to deposition from the atmosphere. It is usually estimated very conservatively in assessments, but even so it makes almost no contribution to the total doses. The critical pathway of exposure from water immersion is by swimming in a home outdoor swimming pool because the shallow depth of water in home pools minimizes dilution of deposited radionuclides. Dose calculation is similar to that for air immersion except that a use factor, often chosen as 0.01 in assessments, is employed to account for the fraction of time spent by a typical person in his home pool.

Ingestion doses resulting from deposition of radionuclides on crop land and pasture are estimated separately for vegetable, meat, and milk consumption. A terrestrial model described later in this report was adopted to estimate steady-state concentrations in these three food types for continuous deposition on agricultural land. Intake by man is calculated from input values assumed for daily consumption of each of the three types of food. Dose conversion factors (rem per microcurie) supplied as input data for each radionuclide and reference organ are used to calculate dose commitments resulting from one year's intake. Dose contributions from radioactive daughters growing in after intake are included in the dose conversion factors for each radionuclide assumed to be ingested.

The number of meat producing animals, dairy cattle, and square meters of area on which vegetable crops are produced is specified for each environmental location in the assessment region. When population doses are to be estimated for a site-specific assessment, any additional quantity (supplemental to locally produced supply) of each of the three food types required to feed the population is assumed to come from outside the assessment area in an uncontaminated state. Options in the code allow the user to specify the fraction of each food type produced at each individual's specific location, the fraction produced within the entire assessment area, and the fraction which is consumed within the area but produced outside the area.

No attempt is made in AIRDOS-EPA to assess either health risks or genetic damage. However, concentrations in air and on ground surfaces and intake rates by man, from which it may be possible to evaluate these effects, are calculated and tabulated for each environmental location for which doses are estimated.

3. ATMOSPHERIC AND TERRESTRIAL TRANSPORT MODELS AND THEIR COMPUTER IMPLEMENTATION

The general organization of the models as implemented in the subroutines of the code are described in detail in this section.

3.1 Organization of the Code

AIRDOS-EPA, written in Fortran-IV computer language, is designed to be run on the IBM-360 computers. It is organized as follows:

MAIN Program

1. SUBROUTINE CONCEN
    1.1 SUBROUTINE QY

- 1.1.1 SUBROUTINE QY1
- 1.1.2 SUBROUTINE QY2
- 1.1.3 SUBROUTINE QY3
- 1.2 SUBROUTINE QX
- 1.3 SUBROUTINE CHIQ

2. SUBROUTINE DIRECT
3. SUBROUTINE DOSEN
    - 3.1 FUNCTION CV
    - 3.2 SUBROUTINE RVALUE
    - 3.3 SUBROUTINE DOSMIC

MAIN is a short program in which options are selected by the user to apply to subroutine CONCEN or subroutine DIRECT. CONCEN calculates and prints out concentrations in air and rates of deposition of radionuclides on ground surfaces from the source term supplied as input. Subroutine DIRECT may be called by MAIN to bypass CONCEN and to supply the above values directly as input.

If CONCEN is called by MAIN, the program can then be terminated, or alternatively, DOSEN will be called. If DIRECT is called by MAIN, DOSEN is then called.

Subroutine QY (and subroutines QY1, QY2, and QY3 called by QY) estimates depletion of radionuclide plumes as a result of dry deposition on ground surfaces. Subroutine QX is used for the same purpose except that it is used for the special cases in which gravitational fall of radionuclide particulates is significant.

Subroutine CHIQ calculates and prints a table of χ/Q values (the ratio of actual concentration in air to the release rate) for each radionuclide in the source term.

Subroutine DOSEN, employing concentrations in air and rates of deposition on ground surfaces calculated in CONCEN or input directly using DIRECT, calculates environmental concentrations, intake rates by man through ingestion and inhalation, and radiation doses. Function CV and subroutine RVALUE are used in the ingestion model of DOSEN.

Subroutine DOSMIC, called by DOSEN, summarizes doses and prints output tables.

3.2 Atmospheric Dispersion and Deposition

Subroutine CONCEN includes models used for plume rise above the top of a stack or roof vent through which radionuclides are released, the atmospheric dispersion model for dilution of radionuclides in an airborne plume while being blown downwind, and models describing deposition processes. Parameter requirements for characterizing the nuclear facility or the site releasing radionuclides, meteorological data requirements, and a detailed description of atmospheric dispersion and deposition models are given below.

3.2.1 Input parameters characterizing the nuclear facility or release site

Input data for CONCEN must include the number of radionuclides (36 maximum) released from the facility, the name of each radionuclide as a representation with a maximum of eight alphameric characters (such as RN-222 for ^{222}Rn) and the annual-average release rate for each radionuclide in units of curies per year. The physical height of the release and the effective diameter for an area source must also be entered. For plume rise calculations based on the momentum of stack gases, the inside diameter of the stack (meters) and the velocity of the stack gases (meters per second) must be entered as input. Plume rise calculations based on buoyancy of hot stack gases requires that the heat release of the stack in calories per second be entered as input.

3.2.2 Meteorological data

The quality of meteorological data for assessment areas varies from that of great detail covering many years of observations taken at meteorological towers located near a site to the other extreme of very sparse information. In some cases, data from sites located some distance away must be used with modifications based on regional mapping of weather conditions. In any case, the data must be summarized in the specific form described below.

First, the annual frequency of wind direction must be determined for each of 16 compass directions starting at direction 1 for wind blowing *toward* due north and proceeding *counterclockwise* through direction 16. Meteorological data are usually presented for the direction *from* which the wind is blowing. The sum of the wind direction frequencies must equal 1.

Next, the frequency of each Pasquill stability category for each of the 16 wind directions must be determined. The extent of vertical and horizontal dispersion of a windblown plume is a function of the stability of the air. Pasquill (1961) described six atmospheric stability categories ranging from A (very unstable) to F (very stable). A seventh category, G (extremely stable), is included in AIRDOS-EPA. The sum of the frequencies for categories A through G will be equal to 1 for *each* of the 16 wind directions. Meteorological data are often not summarized by Pasquill category but instead may be grouped into categories denoted as stable, unstable, and neutral, or may be reported in terms of solar input or vertical temperature gradients. In such cases, conversion to the Pasquill system can be accomplished by reference to established guidelines (Turner, 1969; Slade, 1968).

The average wind speed must be determined for each wind direction and Pasquill category. Meteorological summaries usually present frequencies for various ranges of wind speeds from which the average can be derived. The atmospheric dispersion equation in the code has wind speed in the denominator, however, so a wind speed derived from the average of the reciprocals of wind speeds for the various ranges is used in AIRDOS-EPA as discussed in Sect. 3.2.4. A second set of wind speeds (reciprocal-averaged) must be calculated for each direction and Pasquill category.

The average depth of the atmospheric mixing layer (or lid) for the area must be included. The lid value, which is usually within the range 500 to 2000 m (Holzworth, 1972), is the distance from the ground to the bottom of a more stable layer of air lying above less stable air. The lid restricts the vertical dispersion of an airborne plume after it has travelled some distance downwind of the source. If a specific lid value is not available from site data, it may be estimated from contour maps (Slade, 1968; Holzworth, 1972). The average temperature in the area (°K) is required input if plume rise resulting from buoyancy of hot plumes is calculated by the code.

3.2.3 Plume rise

Gases discharged from a stack or roof vent will rise above the stack as a result of the momentum of the gas or, if the gases are substantially above ambient temperature, because of thermal buoyancy. This plume rise, Δh, when added to the actual physical height of the stack, h, results in an important parameter for dispersion calculations, H, which is referred to as the effective stack height. As a plume is blown downwind from a stack, its centerline, which starts out at the actual physical height of the stack, soon reaches an elevation of H, where it remains unless gravitational settling of particulates produces a downward tilt to the plume or until meteorological conditions change.

Plume rise calculations are subject to much uncertainty. Many equations have been proposed for predicting plume rise, but none has been entirely satisfactory (Turner, 1969). The user can elect, through an option in the main program, to use either the equation given by Rupp et al. (1948) to estimate plume rise for momentum dominated plumes, or to use Briggs' equations (1969) for hot plumes that rise because of buoyancy, or to supply his own values for plume rise.

The equation given by Rupp et al. for momentum dominated plumes is

$$\Delta h = 1.5\, vd/\mu \quad , \tag{1}$$

in which

Δh = plume rise (m),

v = effluent stack gas velocity (m/sec),

d = inside stack diameter (m),

μ = wind velocity (m/sec).

The code treats buoyant plume rise according to Briggs' recommendations in the following way:

For stability categories A, B, C, and D, the equation used is

$$\Delta h = \frac{1.6\ F^{1/3}\ x^{2/3}}{\mu}\ , \tag{2}$$

where

Δh = plume rise (m),

$F = 3.7 \times 10^{-5}\ Q_H$,

x = distance downwind (m),

μ = wind speed (m/sec).

The quantity Q_H is the heat emission from the stack due to the efflux of stack gases in calories per second.

Equation (2) is valid to a point where x is approximately equal to 10h, where the plume levels off. The equation used for values greater than 10h is

$$\Delta h = \frac{1.6\ F^{1/3}\ (10h)^{2/3}}{\mu}\ . \tag{3}$$

Equation (2) is also used for stable categories E, F, and G to a distance $x = 2.4\ \mu S^{-1/2}$, beyond which the plume is assumed to level off. For higher values of x, the equation used is

$$\Delta h = 2.9\left(\frac{F}{\mu S}\right)^{1/3}\ , \tag{4}$$

where S is the stability parameter defined as

$$S = \frac{g}{T_a}\left(\frac{\partial T_a}{\partial z} + \Gamma\right)\ , \tag{5}$$

in which

g = the gravitational acceleration (m/sec^2),

T_a = air temperature (°K),

z = vertical distance above stack (m),

Γ = adiabatic lapse rate of atmosphere (0.0098°K/m) .

The value of the vertical temperature gradient, $\partial T_a/\partial z$, is positive for stable categories.

Equations for both momentum and buoyancy plume rise contain wind speed in the denominator, which obviously produces an unrealistic infinite plume rise for an absolute calm. Very low wind speeds (i.e., a relative calm) could produce unrealistically high values of plume rise. Inclusion of relative calms in averaging plume rise over a series of wind-speed categories can underestimate downwind pollutant concentrations. This is especially true for real meteorological conditions in which wind speed fluctuates considerably during downwind plume travel. An added factor is that the average plume rise is particularly sensitive to wind shear, $d\mu/dz$, at the low wind speeds, which would substantially reduce it from a value calculated using the wind speed at the actual release height. The true average wind speed for each Pasquill stability category is used in the code to estimate plume rise because it is always greater than the reciprocal-averaged wind speed, and therefore produces the most conservative (smallest) plume rise values. This procedure does not risk underestimating the significant contribution of relatively calm periods to downwind pollutant concentrations which could ensue from direct use of a plume rise based on each wind-speed category to be applied to dispersion calculations for that category.

There is, however, no completely satisfactory answer to the plume rise question which covers all meteorological or assessment conditions. For this reason, the option is available to compute plume rise by any other equation or under any other assumptions and to include a value in the input data to be used for each Pasquill atmospheric stability category. The user may use the Rupp equation with true average wind speeds for population dose calculations, for instance, but might wish to use even more conservative values for estimating the highest individual doses in the area to account for local turbulence created by building wakes. In other instances, roof vent releases may be subjected to the influence of other structures in the area so that the user may not wish to account for plume rise at all. In such cases, input values of zero would be used for plume rise. Negative values for plume rise can even be used in some cases to account for downwash, but the effective stack height, of course, should always be maintained above zero. For estimating concentrations of pollutants from buoyant plumes during periods of relative stagnancy (wind speed <1 m/sec), one can use Briggs' (1969) recommended equation for calms ($\Delta h = 5\ F^{1/4}\ S^{-3/8}$) to estimate specific input values for plume rise.

3.2.4 Plume dispersion

The basic equation used to estimate dispersion in an airborne plume as it is blown downwind from a stack is the Gaussian plume equation of Pasquill (1961) as modified by Gifford (1961).

$$\chi = \frac{Q}{2\pi\sigma_y\sigma_z\mu} \exp\left[-\frac{1}{2}\left(\frac{y}{\sigma_y}\right)^2\right]\left\{\exp\left[-\frac{1}{2}\left(\frac{z-H}{\sigma_z}\right)^2\right] + \exp\left[-\frac{1}{2}\left(\frac{z+H}{\sigma_z}\right)^2\right]\right\} \quad , \quad (6)$$

where

χ = concentration in air at x meters downwind, y meters crosswind, and z meters above ground (Ci/m^3),

Q = uniform emission rate from the stack (Ci/sec),

μ = mean wind speed (m/sec),

σ_y = horizontal dispersion coefficient (m),

σ_z = vertical dispersion coefficient (m),

H = effective stack height (physical stack height, h, plus the plume rise, (Δh) (m),

y = crosswind distance (m),

z = vertical distance (m).

The downwind distance x comes into Eq. (6) through σ_y and σ_z, which are functions of x as well as the Pasquill atmospheric stability category applicable during emission from the stack. The code converts χ in Eq. (6) and other plume dispersion equations from units of curies per cubic meter to units of picocuries per cubic centimeter.

Annual-average meteorological data sets usually include frequencies for several wind-speed categories for each wind direction and Pasquill atmospheric stability category. AIRDOS-EPA uses reciprocal-averaged wind speeds in the atmospheric dispersion equations, which permit a single calculation to replace separate calculations for each wind-speed category. This procedure saves much computer running time. The reciprocal averaged wind speed μ_r for each direction and Pasquill category is defined by the equation

$$\frac{1}{\mu_r} = \sum_{1}^{n} \frac{f_n}{\mu_n} , \qquad (7)$$

in which

f_n = fraction of time for wind-speed category n,

μ_n = average wind speed within the wind-speed category n (m/sec).

Equation (6) is applied to ground-level concentrations in air at the centerline of a plume by setting y = 0 and z = 0, which results in

$$\chi = \frac{Q}{\pi \sigma_y \sigma_z \mu} \exp\left[-\frac{1}{2}\left(\frac{H}{\sigma_z}\right)^2\right] . \tag{8}$$

The average ground-level concentration in air over a sector of 22.5°, χ_{ave}, can be approximated by the following expression

$$\chi_{ave} = f\chi \quad , \tag{9}$$

where f is the integral of the exponential expression $\exp\left[-\frac{1}{2}\left(\frac{y}{\sigma_y}\right)^2\right]$ in Eq. (6) from a value of y = 0 to y = ∞ divided by y_s, the value of y at the edge of the 22.5° sector, which is the value of the downwind distance, x, multiplied by the tangent of half of the sector angle. The expression is

$$f = \frac{\int_0^\infty \exp\left[-\left(\frac{0.5}{\sigma_y^2}\right)y^2\right] dy}{y_s} . \tag{10}$$

The definite integral in the numerator of Eq. (10) is evaluated as

$$\sigma_y \sqrt{\frac{\pi}{2}} . \tag{11}$$

Since $y_s = x \tan(11.25°)$,

$$f = \frac{6.300836\ \sigma_y}{x} . \tag{12}$$

The equation for sector-averaged ground level concentration in air is therefore

$$\chi = \frac{Q}{0.15871\ \pi x \sigma_z \mu} \exp\left[-\frac{1}{2}\left(\frac{H}{\sigma_z}\right)^2\right] . \qquad (13)$$

This method of sector-averaging compresses the plume within the bounds of each of the sixteen 22.5° sectors for unstable Pasquill atmospheric stability categories in which horizontal dispersion is great enough to extend significantly beyond the sector edges. It is not a precise method, however, because the integration over the y-axis, which is perpendicular to the downwind direction, x, involves increasing values for x as y is increased from 0 to ∞.

An average lid for the assessment area is provided as part of the input data. The lid is assumed not to affect the plume until x becomes equal to $2x_L$, where x_L is the value of x for which $\sigma_z = 0.47$ times the height of the lid (Turner, 1969). For values of x greater than $2x_L$, vertical dispersion is restricted and radionuclide concentration in air is assumed to be uniform from ground to lid.

The average concentration between ground and lid, which is the ground-level concentration in air for values of x greater than $2x_L$, may be expressed by

$$\chi_{ave} = \frac{\int_0^\infty \chi\, dz}{L} , \qquad (14)$$

where χ is taken from Eq. (6) and L is the lid height. The value of H in Eq. (6) may be set at zero since χ_{ave} is not a function of the effective stack height. The resulting simplified expression

$$\chi_{ave} = \frac{\int_0^\infty \frac{Q}{\pi\sigma_y\sigma_z\mu} \exp\left(-\frac{z^2}{2\ \sigma_z^2}\right) \exp\left(-\frac{y^2}{2\ \sigma_y^2}\right) dz}{L} , \tag{15}$$

may be evaluated for constant x and y values (σ_y and σ_z held constant) by using a definite integral similar to that in Eq. (11). The result is

$$\chi_{ave} = \frac{Q}{2.5066\ \sigma_y L\mu} \exp\left(-\frac{y^2}{2\sigma_y^2}\right). \tag{16}$$

One obtains the sector-averaged concentration at ground level by replacing the exponential expression containing y by f in Eq. (12):

$$\chi_{ave} = \frac{Q}{0.397825\ xL\mu} . \tag{17}$$

It should be noted at this point that for values of the downwind distance greater than $2x_L$, dispersion, as expressed in Eq. (17), no longer can be said to be represented by the Pasquill equation. The model is simply a uniform distribution within a rectangle of dimensions L and 2x tan (11.25°).

Equations (13) and (17) describe the usual case where radionuclides are dispersed downwind as gases or as particulates too small in size to be significantly affected by gravity during plume travel out to 80 to 160 kilometers.

Gravitational settling can be handled in the code, however, by tilting the plume downward after it has leveled off at a value of H by subtracting $V_g x/\mu$ from H in the plume dispersion equations. Values for V_g, the gravitational fall (or settling) velocity in meters per second, are provided as input data for each radionuclide in the source term. The subtracted expression, $V_g x/\mu$, represents the fall of particulates at x meters downwind. For most cases, $V_g = 0$, and the plume centerline remains at an elevation of H. Subtraction of $V_g x/\mu$ from H in Eq. (13) results in the following equation used for sector-averaged ground-level concentration of a radionuclide in air where gravitational settling is involved:

$$\chi = \frac{Q}{0.15871\ \pi x \sigma_z \mu} \exp\left[-\frac{1}{2}\left(\frac{H - V_g x/\mu}{\sigma_z}\right)^2\right] . \qquad (18)$$

A problem arises, of course, if the value of $V_g x/\mu$ becomes greater than H because the centerline of the plume would be below ground level. This problem is solved in the code by a statement which sets the effective stack height equal to zero for all cases where $H - V_g x/\mu$ has a negative value.

3.2.5 Deposition Processes

Particulates and reactive or soluble gases may deposit on ground or water surfaces through two distinctly different processes: (1) dry deposition, and (2) scavenging. These are discussed in the following sections.

3.2.5.1 Dry deposition. Dry deposition is the process by which particles deposit on grass, leaves, and other types of surfaces by impingement, electrostatic interactions, or chemical reactions, or by which gases react chemically with surface components or dissolve in surface moisture.

The rate of deposition on earth surfaces is proportional to the ground-level concentration of the radionuclide in air (Slade, 1968),

$$R_d = V_d\chi \quad , \tag{19}$$

where

R_d = surface deposition rate (pCi/cm^2-sec),

χ = ground-level concentration in air (pCi/cm^3),

V_d = deposition velocity (cm/sec).

It should be stressed here that V_d is merely a proportionality constant even though it has units of velocity. Values of V_d must be obtained from field studies and wind tunnel experiments in which the ratio R_d/χ can be reliably determined. Care should be taken in selecting values for V_d to be sure that the values represent the total deposited radionuclide per unit of ground area and not just the quantity deposited on vegetation, which is often reported in the literature (Hoffman, 1977; Miller et al., 1978). If a radionuclide plume is treated as being tilted downward by gravitational settling, the deposition velocity for the radionuclide should be at least as great as its gravitational fall (or settling) velocity.

3.2.5.2 Scavenging. Scavenging of radionuclides in a plume is the process through which rain or snow removes particles or dissolves gases and deposits them on ground or water. The fraction of particles or soluble gases removed by scavenging from a vertical column of air per unit time during rain or snow is Φ, the scavenging coefficient, which has units of second^{-1}. The rate of deposition from scavenging is

$$R_s = \Phi\chi_{ave}L \quad , \tag{20}$$

where

R_s = surface deposition rate (pCi/cm^2-sec),

Φ = scavenging coefficient (sec^{-1}),

χ_{ave} = average concentration in vertical column up to lid height (pCi/cm^3),

L = lid height (cm).

The scavenging coefficient used for each radionuclide is the sum of scavenging coefficients for washout, rainout, and snowout for particles or the coefficient for dissolving gases in rain drops. The average concentration in the vertical column, χ_{ave}, is computed through use of Eq. (17). The scavenging coefficient is averaged over an entire year, which includes all periods during which rain or snow does not fall. The treatment of scavenging can be described, therefore, as a continuous removal of a fraction of the plume per second over an entire year.

The value for the total ground deposition rate, R_t, computed in subroutine CONCEN for each environmental location, is the sum of R_d and R_s.

3.2.6 Depletion of airborne plumes

Deposition on ground surfaces by dry processes, scavenging, and radioactive decay deplete the airborne plume as it is blown downwind from the release point. Depletion is taken into account by substituting a reduced release rate Q' for the original release rate designated by Q in Eq. (13) and (18) for each downwind distance x (Slade, 1968). For scavenging, the depletion fraction Q'/Q for each x value is the simple exponential expression

$$\frac{Q'}{Q} = e^{-\Phi t} \quad . \tag{21}$$

The value of t is the time in seconds that is required for the plume to reach a point x meters downwind.

The depletion fraction takes a much more complex form for dry deposition. Derivation of this depletion fraction (Van der Hoven, 1968) starts with Eq. (6), where z is set equal to zero for ground-level concentrations and the quantity $V_g x/\mu$ is subtracted from H for a tilted plume:

$$\chi(x, y, 0) = \frac{Q'}{\pi\sigma_y\sigma_z\mu} \exp\left[- \frac{(H - V_g x/\mu)^2}{2\sigma_z^2}\right] \exp\left(-\frac{y^2}{2\sigma_y^2}\right). \tag{22}$$

The rate of deposition on the ground is

$$w(x, y) = V_d\chi(x, y, 0) \quad . \tag{23}$$

Depletion per unit distance downwind is

$$\frac{\partial Q'}{\partial x} = - \int_{-\infty}^{\infty} w(x, y)\, dy \quad . \tag{24}$$

If we let A represent the exponential expression containing H and recognize symmetry, we now have

$$\frac{\partial Q'}{\partial x} = -2 \int_0^{\infty} \frac{Q'V_dA}{\pi\sigma_y\sigma_z\mu} \exp\left(-\frac{y^2}{2\sigma_y^2}\right) dy \quad . \tag{25}$$

The definite integral of Eq. (25) can be evaluated as

$$\frac{\partial Q'}{\partial x} = -\left(\frac{2}{\pi}\right)^{1/2} \frac{Q'V_dA}{\sigma_z\mu} \quad . \tag{26}$$

Then, by integrating

$$\ln\left(\frac{Q'}{Q}\right) = -\left(\frac{2}{\pi}\right)^{1/2} \int_0^x \frac{V_d A}{\sigma_z \mu}\, dx \quad . \tag{27}$$

After substituting for A, the depletion fraction can then be represented by

$$\frac{Q'}{Q} = \exp\left\{-\left(\frac{2}{\pi}\right)^{1/2} \frac{V_d}{\mu} \int_0^x \frac{\exp\left[-\frac{(H - V_g x/\mu)^2}{2\sigma_z^2}\right]}{\sigma_z}\, dx\right\}, \tag{28}$$

for any value of downwind distance x.

The integral expression must be evaluated numerically. Values for the vertical dispersion coefficient σ_z are expressed as functions of x in the form x^D/F where D and F are constants with different values for each Pasquill atmospheric stability category.

Values for the quotient Q'/Q (the depletion fraction) for cases in which $V_g = 0$ are obtained from Subroutine QY, which is called from CONCEN. Subroutine QY obtains depletion fractions for the conditions $V_d = 0.01$ m/sec and $\mu = 1$ m/sec for each Pasquill stability category from the data storage subroutines QY1, QY2, and QY3. These storage subroutines contain values for release heights of 1, 1.5, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12.5, 15, 17.5, 20, 25, 30, 35, 40, 50, 60, 70, 80, 90, 100, 120, 140, 160, 180, 200, 240, 260, 300, and 400 m and for the following downwind distances in meters: 35, 65, 100, 150, 200, 300, 400, 500, 650, 800, 1,000, 1,500, 2,000, 4,000, 7,000, 10,000, 25,000, 60,000, 90,000, and 200,000.

The stored depletion fractions were initially calculated numerically by use of a Simpson's rule computer subroutine. Linear interpolations by QY produce a fraction for the required x value, release height, and Pasquill category for $V_d = 0.01$ m/sec and $\mu = 1$ m/sec. Then, QY converts value to the appropriate value for the actual V_d and μ by use of the equation,

$$\left(\frac{Q'}{Q}\right)_2 = \left(\frac{Q'}{Q}\right)_1^{100\, V_d/\mu} , \tag{29}$$

in which subscript 2 refers to the desired value and subscript 1 refers to the value for $V_d = 0.01$ m/sec and $\mu = 1$ m/sec.

Calculation of depletion fractions by QY through use of stored depletion fractions is a very fast computer process as compared with numerical integration, which would be required otherwise. If V_g, the gravitational fall velocity, is not zero, however, QY cannot be used. In this case, a Simpson's rule subroutine using numerical integration (Subroutine QX) is called by CONCEN to evaluate the depletion fractions.

For downwind distances greater than $2x_L$ where Eq. (16) applies to the ground-level concentration in air, the depletion per unit distance downwind is

$$\frac{\partial Q'}{\partial x} = -\int_{-\infty}^{\infty} \frac{V_d Q'}{2.5066\, \sigma_y L \mu} \exp\left(-\frac{y^2}{2\, \sigma_y^2}\right) dy \ . \tag{30}$$

Integration is accomplished by using the definite integral

$$\int_0^\infty \exp\,(-a^2y^2)\;dy = \frac{\sqrt{\pi}}{2a} \quad , \tag{31}$$

where $a = 1/(\sqrt{2}\;\sigma_y)$. The resulting equation

$$d\;\ln Q' = -\frac{V_d}{L\mu}\;dx \quad , \tag{32}$$

when integrated from $2x_L$ to x produces the relationship

$$\frac{Q'_x}{Q'_{2x_L}} = \exp\left[-\;\frac{V_d(x - 2x_L)}{L\mu}\right] \quad , \tag{33}$$

in which Q'_x and Q'_{2x_L} are the reduced release rates at distances x and $2x_L$, respectively, for x values greater than $2x_L$. The depletion fraction at $2x_L$, Q'_{2x_L}/Q, obtained from Eq. (28) is multiplied by Q'_x/Q'_{2x_L} in Eq. (33) to give the depletion fraction at x, Q'_x/Q.

Use of a reduced release rate to estimate depletion by dry processes, referred to as the source depletion model, is a descriptively unrealistic treatment because it removes material from the entire vertical column, while, in fact, removal occurs only at the bottom of a plume. Proposed surface depletion models (Markee, 1967; Horst, 1977) have not come into general use, however, because of their computational complexities and because concentrations in air calculated from these models do not differ greatly from those calculated using source depletion for elevated releases and moderate deposition strength (Horst, 1977; Miller et al., 1978). The source depletion model as implemented in AIRDOS-EPA meets the important requirements of maintaining material balance as a plume is blown downwind of a source.

The depletion fraction for radioactive decay is

$$\frac{Q'}{Q} = e^{-\lambda_r t} \tag{34}$$

in which λ_r is the radioactive decay constant and t is the time required for plume travel. The decay constant used in CONCEN is referred to as the "effective decay constant" since it is not the true radiological decay constant for a radionuclide λ_i in all cases. For example, if a radionuclide is a short-lived daughter in equilibrium with a longer-lived parent, the effective decay constant for the daughter would be the true radiological decay constant of its parent.

The overall depletion fraction used in the code is the product of the depletion fractions for dry deposition, scavenging, and radioactive decay.

The atmospheric dispersion equations use the reciprocal-averaged wind speed μ_r but neither μ_r nor the true average wind speed μ_a can adequately be used to calculate reduced release rates to account for radiological decay and scavenging losses because averaging of exponential terms is required. An approximate calculational method used in AIRDOS-EPA for this purpose involves establishing three wind speeds (1 m/sec, μ_a m/sec, and 6 m/sec) to simulate the actual wind-speed spectrum for each specific wind direction and Pasquill category. The wind speeds 1 and 6 m/sec were chosen because they approximate the upper and lower bounds in most meteorological data sets.

If f_1, f_2, and f_3 are designated as the time fractions for wind speeds 1, μ_a, and 6 m/sec, respectively, then

$$f_1 + \mu_a f_2 + 6f_3 = \mu_a \quad , \tag{35}$$

$$f_1 + \frac{f_2}{\mu_a} + \frac{f_3}{6} = \frac{1}{\mu_r} \quad , \tag{36}$$

and

$$f_1 + f_2 + f_3 = 1 \quad . \tag{37}$$

Solving the above three simultaneous equations results in

$$f_2 = \frac{\frac{7}{6} - \frac{\mu_a}{6} - \frac{1}{\mu_r}}{\frac{7}{6} - \frac{\mu_a}{6} - \frac{1}{\mu_a}} \quad , \tag{38}$$

$$f_3 = \frac{(\mu_a - 1)(1 - f_2)}{5} \quad , \tag{39}$$

and

$$f_1 = 1 - f_2 - f_3 \quad . \tag{40}$$

The depletion fraction to account for radioactive decay is then approximated by

$$f_1 \exp\,(-\lambda_r x) + f_2 \exp\left[-\lambda_r\left(\frac{x}{\mu_a}\right)\right] + f_3 \exp\left[-\lambda_r\left(\frac{x}{6}\right)\right] \tag{41}$$

in which x is the downwind distance in meters and λ_r is the decay constant in units of seconds^{-1}. Similarly, the depletion fraction accounting for scavenging losses is

$$f_1 \exp\,(-\Phi x) + f_2 \exp\left[-\Phi\left(\frac{x}{\mu_a}\right)\right] + f_3 \exp\left[-\Phi\left(\frac{x}{6}\right)\right] \quad . \tag{42}$$

The overall depletion fraction is

$$\frac{Q'}{Q} = \left(\frac{Q'}{Q}\right)_{dry} \left\{ f_1 \exp\,(-\lambda_r x) + f_2 \exp\left[-\lambda_r\left(\frac{x}{\mu_a}\right)\right] + f_3 \exp\left[-\lambda_r\left(\frac{x}{6}\right)\right] \right\}$$

$$\left\{ f_1 \exp\,(-\Phi x) + f_2 \exp\left[-\Phi\left(\frac{x}{\mu_a}\right)\right] + f_3 \exp\left[-\Phi\left(\frac{x}{6}\right)\right] \right\} \qquad (43)$$

in which $\left(\frac{Q'}{Q}\right)_{dry}$ is the depletion fraction for dry deposition.

3.2.7 Values of parameters used in dispersion equations

The values of the horizontal and vertical dispersion coefficients, σ_y and σ_z (Table 1), used for dispersion calculations in CONCEN and to calculate depletion fractions in QY and QX are those recommended by G. A. Briggs of the Atmospheric Turbulence and Diffusion Laboratory at Oak Ridge, Tennessee (Gifford, 1976). These values, which are different functions of the downwind distance x for each of the Pasquill stability categories A through F, are used in the code as the functions $\sigma_y = x^A/C$ and $\sigma_z = x^D/F$ to facilitate integrations over x. The parameters A, C, D, and F for each Pasquill atmospheric stability category and specific ranges of x are stored in a data statement. Pasquill category G (extremely stable) was added to the code. Values for σ_y and σ_z for category G were derived by subtracting half of the difference between values for categories E and F from the values for F for each downwind distance.

Reciprocal-averaged wind speeds for each wind direction and Pasquill category are used for μ values in the dispersion equations instead of the true average values because μ is in the denominator of the equations. The process of averaging over a series of ranges of wind speeds actually involves averaging a series of terms containing the factors $1/\mu_1$, $1/\mu_2$, $1/\mu_3$, etc.

Table 1. Formulas recommended by Briggs[a] for σ_y and σ_z for open-country conditions[b]

Pasquill type	σ_y (m)	σ_z (m)
A	$0.22\ x\ (1 + 0.0001\ x)^{-1/2}$	$0.20\ x$
B	$0.16\ x\ (1 + 0.0001\ x)^{-1/2}$	$0.12\ x$
C	$0.11\ x\ (1 + 0.0001\ x)^{-1/2}$	$0.08\ x\ (1 + 0.0002\ x)^{-1/2}$
D	$0.08\ x\ (1 + 0.0001\ x)^{-1/2}$	$0.06\ x\ (1 + 0.0015\ x)^{-1/2}$
E	$0.06\ x\ (1 + 0.0001\ x)^{-1/2}$	$0.03\ x\ (1 + 0.0003\ x)^{-1}$
F	$0.04\ x\ (1 + 0.0001\ x)^{-1/2}$	$0.016\ x\ (1 + 0.0003\ x)^{-1}$

[a] G. A. Briggs, Air Resources Atmospheric Turbulence and Diffusion Laboratory National Oceanic and Atmospheric Administration, Oak Ridge, Tennessee.

[b] Values of x are downwind distances in meters.

3.2.8 χ/Q tabulations

The value χ/Q is the actual concentration of the radionuclide in air at ground level divided by the release rate of the radionuclide. Subroutine CHIQ called from CONCEN calculates χ/Q values and prints a table for each radionuclide listing χ/Q values in seconds per cubic meter for each of the 16 compass directions for the specific downwind distances (from 1 to 20) supplied as input. The χ/Q values are not calculated if the assessment area is a square grid.

3.2.9 Area sources

At the option of the user, the source can be a finite area with the reference point for the grid system at its centroid. Radionuclides are assumed to be released uniformly throughout the area. The method used to estimate environmental concentrations resulting from area releases is a modification by Christopher B. Nelson (EPA) of the method described by Mills and Reeves (1973) and implemented by Culkowski and Patterson (1976).

The method consists basically of transforming the original area source into an annular segment with the same area. This transformation is dependent on the distance between the centroid of the area source and the receptor. At large distances the transformed area source approaches a point source at the origin while at distances very close to the centroid it becomes a circular source centered at the receptor.

The principle of reciprocity is used to calculate the effective χ/Q. That is, the problem is equivalent to interchanging source and receptor and calculating the mean χ/Q from a point source to one or more sector segments according to the angular width of the transformed source. The mean value of χ/Q for each sector segment is estimated by calculating χ/Q at the distance which would provide the exact value of the mean if the variation in χ/Q were proportional to $r^{-1.5}$ for distances from the point source to locations within the sector segment. The χ/Q for the entire transformed source is the sum of the χ/Q values for each sector weighted by the portion of the total annular source contained in that sector.

Point-source χ/Q values for a typical annual-average meteorology were found to be nearly identical to those for a circular area source with a diameter of 718 m at distances greater than 1600 m from its center. For this reason, the code includes a statement providing default to point-source treatment if the ratio of downwind distance to source diameter exceeds 2.5.

Any uncertainties in the area-source treatment stemming from the assumption that χ/Q is proportional to $x^{-1.5}$ or other assumptions in the model are applicable only to locations near the edge of an area source. Comparisons were made of calculated concentrations in air at ground level with values calculated by AREAS (Moore, 1978), an area-source code based on entirely different principles, which was developed to evaluate widely dispersed pollutant sources within a 20 by 20 square grid system. A 718-m diameter circular area was used. Agreement was within 10% at distances greater than 600 m from the edge of the area source. The AREAS values were 20% higher at 330 m and 90% higher at 100 m from the edge.

The differences found within a few hundred meters from the edge of the source may not be relevant, however, because, the AREAS values represent averages over a square grid. The average can differ substantially from the actual value for a receptor point located in a region of rapidly changing χ/Q. Nevertheless, caution should be exercised when applying the area-source treatment where the ratio of distance from the center to the diameter of a source is less than ∿1.3.

3.2.10 Limitations of the dispersion treatment

The AIRDOS-EPA treatment of dispersion uses the Gaussian plume equation. This equation is an empirical formula which is based on an analytical solution to the diffusion equation under the restrictive assumptions of constant wind speed, no wind shear, flat topography, Fickian diffusion, and no chemical or physical interactions of plume components during plume travel. The parameters σ_y and σ_z are not defined explicitly by the mathematical assumptions of the model. They must be determined empirically. The Gaussian plume equation has shown considerable success under ideal field test conditions. However, dispersion in plumes is increased by surface roughness caused by buildings, hills, and other environmental factors. Thermal sources present in urban areas also increase dispersion. The meteorological data employed in an assessment near a source for which these factors are significant should reflect this increased atmospheric instability.

There is a lower limit of applicability of the Pasquill equation with respect to wind speed. Dispersion is treated only in crosswind and vertical directions and is ignored in the downwind direction. Consequently, χ unrealistically approaches ∞ as wind speed approaches zero. The contribution of periods of relative calm, which significantly affect average pollutant concentrations, may therefore be overestimated. Wind speeds much less than 1 m/sec should probably not be used in dispersion estimates.

The ideal plume described by the Pasquill equation often does not exist under real atmospheric conditions. Instantaneous changes in wind direction, and updrafts and downdrafts produced by terrain features and other meteorological changes produce significant deviations from the ideal plume. Many of these deviations average out, however, when the equation is used to estimate average concentrations of pollutants released continuously from a source.

The dispersion treatment in AIRDOS-EPA assumes a continuous plume extending indefinitely outward from the source in a single direction with a single wind speed and atmospheric stability. Fractional contributions to downwind concentrations in each compass direction are based on frequencies of wind speed and stability category. Realistically, however, wind speed and direction often fluctuate almost continuously, and the atmospheric stability will ultimately change as a plume is blown downwind. Also, deviations from site-specific annual-average meteorology can be expected at locations beyond a few miles from the plant site.

These limiting factors as applied to dose assessments can be resolved into two components: (1) factors affecting estimation of the highest individual dose in the area, and (2) factors affecting population dose estimates. The highest individual doses are usually close to the release point — at the plant boundary at distances from the source of perhaps 800 to 1000 m or less for low-level releases or at distances of only a few thousand meters for elevated releases. The Gaussian model as applied to annual-average meteorology using sector averaging is generally regarded as applicable over these short distances. Uncertainties arise mainly because of possible air turbulence or downdrafts created by buildings and other structures in the immediate plant area. Correction for building effects can be accomplished in a conservative manner by reducing the effective stack height.

Population dose assessments depend largely on estimated concentrations at greater distances. Uncertainties arising specifically from the use of the Pasquill equation are eliminated at distances far enough downwind that vertical dispersion is restricted by the lid. At such distances sector-averaged dispersion is simply calculated as proportional to the area of a rectangle with dimensions of the lid height and the cross-section distance. The most serious question here concerns deviations from site-specific meteorology, particularly with respect to frequencies of wind direction. For a relatively uniform population distribution, population dose estimates should be fairly reliable to the extent that atmospheric dispersion is involved. On the other hand, if a heavily populated area lies far out from the source, but within the assessment area and contributes substantially to the calculated population dose, a correction may have to be made for changes in frequencies of wind direction.

Lid heights are not known precisely, and they vary greatly from season to season and even change greatly from daylight to dark and vice versa when solar input changes. Uncertainties in lid values can result in dose uncertainties for those downwind distances great enough that vertical dispersion is restricted by the lid. This would not usually affect areas close to the plant where the highest individual dose will be received but may affect population dose to some extent. The treatment in the code would seem to overestimate concentrations at all distances somewhat, however, by not considering lid penetration. This effect can occur at certain times, such as in early morning, when a low lid lying just above the top of a stack is penetrated by the stack gases. Pollutants can be blown out of the area under these conditions without dispersing downward at all. Conditions for lid penetration are infrequent at most sites. Ignoring the effect, therefore, probably does not greatly affect dose estimates, but it does impart a small degree of conservatism to the calculations.

3.2.11 Direct input of concentrations in air and rates of deposition on ground surfaces (subroutine DIRECT)

Environmental concentrations, intake rates by man, and radiation doses can be calculated in AIRDOS-EPA from concentrations in air and ground deposition rates provided directly as input to the code by specifying OPTION (1) = 2 in MAIN. Subroutine DIRECT is called by this option, which bypasses CONCEN, the atmospheric dispersion subroutine. Data required for DIRECT are (1) integers specifving the lower and upper bounds of the assessment area; (2) SQSD, as also required in CONCEN; (3) the specific downwind distances (IDIST values) for the circular option; (4) S_e (SEQWL), the assumed fraction of equilibrium for ^{222}Rn short-life progeny used for working level (WL) calculations; (5) number of radionuclides (NNUCS); and (6) a data set for each radionuclide consisting of the name of the radionuclide, its deposition velocity, and its scavenging coefficient, followed by 400 air concentrations in a 20 by 20 array and 400 ground deposition rates in the same format. Tables of the input data are printed listing air concentrations, and the dry, wet, and total deposition rates. These data are used in DOSEN to calculate doses, environmental concentrations, and rates of intake by man.

3.3 Calculations of Radiation Doses, Environmental Concentrations, and Intake Rates by Man

Subroutine DOSEN, called from the main program, estimates doses, concentrations, and intake rates at specified environmental locations through the use of ground-level concentrations in air and ground deposition rates computed in Subroutine CONCEN or provided directly as input. Doses are estimated for 11 organs including total body. Modes of exposure described below are (1) immersion in air, (2) exposure to ground surfaces contaminated by deposited radionuclides, (3) immersion in water such as by swimming in a backyard pool, (4) inhalation of air containing radionuclides, and (5) ingestion of food produced on contaminated land.

3.3.1 Air immersion doses

The equation used for estimating external doses from immersion in air containing gamma emitting radionuclides is

$$D_{imm} = (1.0 \times 10^{-6})(8760)\ \chi\ C_{imm} \quad , \tag{44}$$

in which

D_{imm} = air immersion dose (rem/year),

χ = ground-level concentration of the radionuclide in air (pCi/cm^3),

C_{imm} = dose conversion factor for immersion in an infinite cloud ($rems\text{-}cm^3/\mu Ci\ hr$),

1.0×10^{-6} = $\mu Ci/pCi$,

8760 = hr/year.

The code receives a skin dose conversion factor as input data for each radionuclide for infinite cloud exposure. This skin dose conversion factor is multiplied in the code by an external dose correction factor (FROG) for total body and each reference organ, also supplied as input data for each radionuclide.

Equation (44) applies to environmental locations at which the airborne plume has essentially reached ground level. It can, however, overestimate doses near a low-level release because of the small vertical spread of the plume under these conditions. On the other hand, Eq. (44) can underestimate dose for overhead plumes at locations close to the stack where χ may be very low, but where the individual may be irradiated from above. A case in point would be a release of energetic gamma emitters from a tall stack of a plant with a close-in plant boundary. For such a case, a separate calculation should be made for dose from the overhead plume, and this dose should be added to the immersion dose calculated by Eq. (44).

3.3.2 Surface exposure doses

Dose due to gamma emissions from radionuclides deposited on ground surfaces is estimated by

$$D_{surf} = (1.0 \times 10^{-6})(8760)R_t \frac{1 - \exp(-\lambda_T t)}{\lambda_T} (86400)C_{surf} \quad , \qquad (45)$$

where

D_{surf} = dose from surface exposure (rems/year),

R_t = surface deposition rate (pCi/cm^2-sec),

λ_T = radioactive decay constant λ_r + environmental decay constant λ_w (day^{-1}),

t = time allotted for surface buildup (days),

C_{surf} = dose conversion factor for surface exposure to an infinite plane at a point 1 m above ground (rems-cm^2/μCi hr),

1.0×10^{-6} = μCi/pCi,

8760 = hr/year,

86400 = sec/day,

Input data includes a skin surface dose conversion factor which is multiplied in the AIRDOS-EPA code by external dose correction factors (FROG) for total body and reference organs.

The expression in Eq. (45),

$$R_t \frac{1 - \exp(-\lambda_T t)}{\lambda_T} (86400) \quad , \qquad (46)$$

represents the surface concentration in picocuries per square centimeter after a buildup time of t days. There is very little available information on environmental removal rates from ground surfaces, so a value of zero is usually used for the environmental decay constant. The value of λ_T then would be simply the radiological decay constant.

3.3.3 Water immersion doses

Doses resulting from immersion in water subjected to deposition of radionuclides from the atmosphere are estimated similarly to those resulting from air immersion. The ultimate concentration of a radionuclide in a body of water is inversely proportional to its depth, so swimming in a shallow body of water such as a backyard swimming pool is taken as representing the most significant exposure pathway for water immersion. Water immersion doses are included in DOSEN for completeness but normally do not contribute significantly to total dose even though assumed parameters for assessments are usually very conservative.

The equation is

$$D_{wimm} = (1.0 \times 10^{-6})(8760)\,\frac{R_t}{d}\,\frac{1 - \exp(-\lambda_T t)}{\lambda_T}\,(86400)C_{wimm} \quad , \qquad (47)$$

in which

D_{wimm} = water immersion dose (rem/year),

R_t = surface deposition rate (pCi/cm^2-sec),

d = depth of water (cm),

λ_T = radioactive decay constant λ_r + environmental decay constant for water λ_w (day^{-1}),

t = time allotted for buildup in water (days),

C_{wimm} = dose conversion factor for immersion in a body of water of infinite dimensions (rems-cm^3/μCi-hr),

1.0×10^{-6} = μCi/pCi,

8760 = hr/year,

86400 = sec/day .

3.3.4 Inhalation doses

The following equation is used to estimate inhalation dose at each environmental location:

$$D_{inh} = (1.0 \times 10^{-6})(8760)\,\chi\,B_r C_{inh} \quad , \qquad (48)$$

where

D_{inh} = inhalation dose (rem/year),

χ = ground-level concentration of the radionuclide in air (pCi/cm^3),

B_r = breathing rate (cm^3/hr),

C_{inh} = dose conversion factor for inhalation (rem/μCi),

1.0×10^{-6} = μCi/pCi,

8760 = hr/year.

The C_{inh} values are dose commitment resulting from the initial intake of 1 μCi for the radionuclide. These dose conversion factors should include contributions of radioactive daughters growing in after the intake of the parent nuclide.

3.3.5 Ingestion doses

Doses to the various organs from the ingestion of radionuclides other than ^{3}H (tritium) and ^{14}C are calculated from radionuclide concentrations in food and annual consumption rates for individuals or populations. Radionuclide concentrations in meat, milk, and vegetables are calculated through implementation of models described in U.S. Nuclear Regulatory Commission (NRC) Regulatory Guide 1.109 (1977). The models are described below by Pleasant (1979).

3.3.5.1 Concentrations in and on vegetation. Radioactive material concentrates in vegetation as a result of deposition onto the plant foliage and from uptake of activity initially deposited on the ground. The following equation is used for estimating the concentration $C_i^v(r, \theta)$ in picocuries per kilogram of nuclide i in and on vegetation at the location (r, θ):

$$C_i^v(r, \theta) = d_i(r, \theta) \left\{ \frac{R[1 - \exp(-\lambda_{Ei} t_e)]}{Y_v \lambda_{Ei}} + \frac{B_{iv}[1 - \exp(-\lambda_i t_b)]}{P \lambda_i} \right\} \exp(-\lambda_i t_h), \quad (49)$$

where

$d_i(r, \theta)$ = the deposition rate of radionuclide i onto ground at location (r, θ), in pCi/m^2-hr $(d_i(r, \theta) = 3.6 \times 10^7 R_t)$;

R = the fraction of deposited activity retained on edible portions of crops, dimensionless;

λ_i = the radioactive decay constant of nuclide i, in hr^{-1};

λ_{Ei} = the effective removal rate constant for radionuclide i from crops, in hr^{-1}, where $\lambda_{Ei} = \lambda_i + \lambda_w$, and λ_w is the removal rate constant for physical loss by weathering;

t_e = the time period that crops are exposed to contamination during the growing season, in hr;

Y_v = the agricultural productivity (yield), of the edible portion of vegetation in kg/m^2;

B_{iv} = the concentration factor for uptake of radionuclide i from soil by edible parts of crops, in pCi/kg per pCi/kg dry soil;

t_b = the period of long-term buildup for activity in soil, in hr;

P = the effective density of the top 15 cm of soil, in kg(dry soil)/m^2;

t_h = a holdup time that represents the time interval between harvest and consumption of the vegetation, in hr.

In the AIRDOS-EPA code, when Eq. (49) is used to calculate C_i^V for pasture grasses, Y_{v1} and B_{iv1} values based on dry weight, are used for Y_v and B_{iv}. When the equation is used for fresh produce ingested by man, fresh weight values Y_{v2} and B_{iv2} are used. In addition a washing factor DD1 is multiplied by the first term of Eq. (49) to account for removal of surface-adhered radionuclides during processing of food consumed by man.

The above model has several conceptual limitations. The model may overestimate radionuclide concentrations in vegetation via root uptake because the model assumes that radiological decay is the only removal process from the soil. However, harvesting of vegetable crops, grazing of pasture grasses, erosion of soil, and leaching of radionuclides in percolating water may also remove radionuclides from the root zone soil. The model may also underestimate radionuclide concentrations in vegetation because radionuclides initially deposited on vegetation surfaces may be incorporated directly into the plant matrix and not be completely removed by environmental processes. Additionally, the model does not attempt to simulate daughter buildup in the vegetation. A method to account for daughter buildup in the AIRDOS-EPA code will be discussed elsewhere in this report.

3.3.5.2 Concentrations in milk. The concentration of radionuclide i in milk depends upon the amount and contamination level of the feed consumed by the animal. The concentration of radionuclide i in the animal's feed is calculated by use of the equation

$$C_i^V(r, \theta) = f_p f_s C_i^p(r, \theta) + (1 - f_p f_s) C_i^s(r, \theta), \tag{50}$$

where

$C_i^V(r, \theta)$ = the concentration of radionuclide i in the animal's feed, in pCi/kg;

$C_i^p(r, \theta)$ = the concentration of radionuclide i on pasture grass [calculated using Eq. (49) with $t_h = 0$], in pCi/kg;

$C_i^S(r, \theta)$ = the concentration of radionuclide i in stored feeds [calculated using Eq. (49) with t_h = 2160 hr (90 days)], in pCi/kg;

f_p = the fraction of the year that animals graze on pasture,

f_s = the fraction of daily feed that is pasture grass when the animals graze on pasture.

Using the value of $C_i^V(r, \theta)$ calculated by use of this equation, the concentration of radionuclide i in milk is estimated as

$$C_i^M(r, \theta) = F_m C_i^V(r, \theta) Q_F \exp(-\lambda_i t_f) \ , \tag{51}$$

where

$C_i^M(r, \theta)$ = the concentration in milk of nuclide i, in pCi/liter;

$C_i^V(r, \theta)$ = the concentration of radionuclide i in the animal's feed, in pCi/kg;

F_m = the average fraction of the animal's daily intake of radionuclide i which appears in each liter of milk, in days/liter;

Q_F = the amount of feed consumed by the animal per day, in kg/day;

t_f = the average transport time of the activity from the feed into the milk and to the receptor;

λ_i = the radiological decay constant of nuclide i, in days^{-1}.

3.3.5.3 Concentrations in meat. The radionuclide concentration in meat depends upon the amount and contamination level of the feed consumed by the animal, as in the milk pathway. Using the value of $C_i^V(r, \theta)$ as calculated in Eq. (50), the radionuclide concentration in meat is estimated as

$$C_i^F(r, \theta) = F_f C_i^V(r, \theta) Q_F \exp(-\lambda_i t_s) \ , \tag{52}$$

where

$C_i^F(r, \theta)$ = the concentration of nuclide i in animal flesh, in pCi/kg;

F_f = the fraction of the animal's daily intake of nuclide i which appears in each kilogram of flesh, in days/kg;

$C_i^V(r, \theta)$ = the concentration of radionuclide i in the animal's feed, in pCi/kg;

Q_F = the amount of feed consumed by the animal per day, in kg/day;

λ_i = the radiological decay constant of nuclide i, in days^{-1};

t_s = the average time (days) from slaughter to consumption.

For concentration in beef, it is assumed that beef cattle are on open pasture for the same grazing periods as given for milk cattle.

3.3.5.4 Calculation of annual organ doses. The following equation is used to calculate the annual dose committed to organ j of an individual resulting from ingestion of all radionuclides other than ^3H and ^{14}C in produce, milk, meat, and leafy vegetables.

$$D_j^D(r, \theta) = \sum_i DFI_{ij}[U^V f_g C_i^V(r, \theta) + U^M C_i^M(r, \theta) + U^F C_i^F(r, \theta) + U^L f_\ell C_i^L(r, \theta)] , \quad (53)$$

where

$D_j^D(r, \theta)$ = the annual dose committed to organ j of an individual from dietary intake of atmospherically released radionuclides;

DFI_{ij} = the dose conversion factor for the ingestion of nuclide i for organ j in millirem/pCi;

U^V, U^M, U^F, U^L = the ingestion rates of produce (nonleafy vegetables, fruit, and grains), milk, meat, and leafy vegetables, respectively, for individuals;

f_g = the fraction of produce ingested grown in garden of interest;

f_ℓ = the fraction of leafy vegetables grown in garden of interest.

The terms in Eq. (53) containing $C_j^V(r, \theta)$, $C_j^M(r, \theta)$, $C_j^F(r, \theta)$, and $C_j^L(r, \theta)$ represent the dose to organ j from ingestion of produce, milk, meat, and leafy vegetables, respectively. Equations (51) and (52) are used to calculate $C_j^M(r, \theta)$ and $C_j^F(r, \theta)$, respectively. Equation (49) is used to calculate $C_j^V(r, \theta)$; the values used for the parameters t_e, Y_v, and t_h are those appropriate for produce consumed by man. Similarly Eq. (49) is used to calculate $C_j^L(r, \theta)$ with parameter values t_e, Y_v, and t_h chosen so as to be appropriate for leafy vegetables consumed by man.

Dose conversion factors for dose commitments resulting from an annual intake of a radionuclide are provided as input to the code in units of rem per microcurie and are converted to units of millirem per picocurie for use in Eq. (53). The dose conversion factors should include contributions by both the radionuclides and its daughters growing in after intake. Doses resulting from ingestion of produce and leafy vegetables are combined in DOSEN and designated simply as vegetable doses.

Input data required for calculation of ingestion doses include number of meat producing animals, number of dairy cattle, and area (square meters) of vegetable crop production for each environmental location. The area of land associated with an environmental location is the grid area if the 20 by 20 square grid option is used. For the circular option, the area is that of the portion of a 22.5° sector having the environmental location at its central point. Population data for each location are included for population dose calculations.

Various possible assumptions with regard to food sources can be handled within the code. For each of the three types of food, a number is included in the input data that specifies the ratio

$$A/(A + B) \qquad (54)$$

in which

A = quantity ingested which is produced at the individual's environmental location, and

B = quantity ingested whose source represents an average produced over the assessment area.

Another number for each food type specifies the *minimum* fraction the individual ingests that comes from outside the assessment area altogether and that is assumed to contain no radionuclides. The fraction imported for each type of food may be calculated by the code and can be greater than this minimum value if needed to meet the nutritional requirements for the population. The user can exercise an option, however, to fix the minimum value so that it will not be exceeded under any conditions.

If it were desired not to consider ingestion at all, each of the three minimum fractions imported could be set at 1.0. For calculations of the maximum individual dose in the area, it is usually desirable to set and fix the minimum fraction to be imported at zero. If the ratios defined in Eq. (54) each have values of 1.0, complete availability of each of the three food types produced at the individual's specific location is assumed in the code regardless of input values used for numbers of meat producing animals and dairy cattle or area of vegetable crop production.

3.3.6 Calculations for special cases

If a radionuclide interacts with environmental components in a unique fashion, it must be treated as a special case. Tritium (^3H) and ^{14}C are given special treatment in Subroutine DOSEN because the stable forms of these elements constitute significant fractions of the elemental composition of the human body and man's food and drink. Transport processes within soil, plants, cattle, and man which apply to trace quantities of radionuclides do not necessarily apply to cases where the corresponding stable elements are present in such quantities that saturation effects are significant.

If tritium (T) is released to the atmosphere as HT or T_2, atoms of T may exchange with hydrogen atoms in water molecules in the air, and we may wish to treat the plume as though it contained HTO initially. The tritium may then be assumed to follow water almost precisely through the environment. For this reason doses from drinking water are included for tritium. Rather than attempting to relate the doses to the ground deposition rate, it is assumed that doses from ingestion of food and drinking water at an environmental location are proportional to tritium concentration in the air (Killough and McKay, 1976).

The total ingestion dose from tritium if the source of all of an individual's food and drinking water is assumed to be at his specific environmental location is

$$D_t = C_f \chi + C_w \chi \qquad (55)$$

where

D_t = total ingestion dose (rem/year),

C_f = dose conversion factor for food (rem-cm^3/pCi-year),

C_w = dose conversion factor for drinking water (rem-cm^3/pCi-year),

χ = ground-level concentration of tritium in air at an environmental location (pCi/cm^3).

For the purpose of summarizing in the code the food ingestion pathways for all radionuclides in a source term, the tritium ingestion dose from food is artificially broken down into ingestion doses from vegetables (D_v), meat (D_b), and milk (D_c). The total food ingestion dose from tritium (D_t) is equal to the sum of D_v, D_b, and D_c. The equations used in the code are

$$D_v = 0.505\ C_f(f_{v1}\chi + f_{v2}\chi_v) \quad , \tag{56}$$

$$D_b = 0.185\ C_f(f_{b1}\chi + f_{b2}\chi_b) \quad , \tag{57}$$

$$D_c = 0.310\ C_f(f_{c1}\chi + f_{c2}\chi_c) \quad , \tag{58}$$

where

D_v, D_b, and D_c = tritium food ingestion dose from vegetables, meat, and milk, respectively (rem/year),

χ_v = average ground-level concentration of tritium in air over the assessment area weighted by quantities of vegetables produced as a function of location,

χ_b = as above for χ_v except applied to meat,

χ_c = as above for χ_v except applied to milk,

f_{v1} = fraction of vegetable intake which is produced at individual's environmental location,

f_{v2} = fraction of vegetable intake whose source represents an average produced over the assessment area,

f_{b1} = as above for f_{v1} except applied to meat,

f_{b2} = as above for f_{v2} except applied to meat,

f_{c1} = as above for f_{v1} except applied to milk,

f_{c2} = as above for f_{v2} except applied to milk,

0.505 = the fraction of C_f for vegetable ingestion,

0.185 = the fraction of C_f for meat ingestion,

0.310 = the fraction of C_f for milk ingestion.

The total-body dose conversion factor for ingestion is 8.3×10^{-5} rem per microcurie (Killough et al., 1978). This number is used to derive the value of C_f, based on the specific activity of tritium in atmospheric moisture with an average specific humidity of 8 grams of H_2O per cubic meter of air (Killough and McKay, 1976). If tritium in food is in equilibrium with atmospheric tritium and man consumes 1638 g of water daily in his food, C_f is 6.18 rem-cm^3/pCi-year. The C_w value for an assumed daily drinking water intake of 1512 g is 5.70 rem-cm^3/pCi-year. This value should be used, however, only if the source of each individual's drinking water is assumed to be at his specific environmental location. For all other cases, C_w should be reduced to account for dilution by distant sources.

The code breaks down the food ingestion dose from tritium into percentage contributions of 50.5% from vegetables, 18.5% from meat, and 31.0% from milk. The percentages are based on approximate water contents of foods: 82.4% for vegetables, 62.3% for meat, 87.5% for milk (Moore, 1977), for daily intakes of 0.532 kg of vegetables, 0.258 kg of meat, and 0.307 kg of milk (Rupp, 1979).

Tritium is the only radionuclide in a source term in which the total dose estimated to derive from vegetables, meat, and milk may not equal the total ingestion dose. The difference is the dose from drinking water.

Tritium doses via inhalation of air and skin absorption are estimated by the code and added to the dose estimated to be received via ingestion. The dose conversion factor for inhalation of air containing tritium includes a contribution for skin absorption from air.

If ^{14}C is released in the form of CO_2, it will mix with atmospheric CO_2, and become available for plant photosynthesis. Cattle grazing on pasture will take in ^{14}C in grass, and then man will receive it in milk and beef. Factors in a data statement are used in the code to multiply by the concentration of ^{14}C in air to obtain an ingestion dose for each reference organ. These dose conversion factors, listed in Table 2, are based on specific activity calculations for ^{14}C in body tissues in equilibrium with atmospheric ^{14}C (Killough and Rohwer, 1978).

Nearly all of the ^{14}C doses come from ingestion. Breakdown by the three food pathways is accomplished by estimating carbon intakes for meat, milk, and vegetables. The weight of total carbon intake per day is approximated by the relations (Moore, 1977)

$$W_v = 79.96\ V \quad , \tag{59}$$

$$W_b = 238.16\ T_b \quad , \tag{60}$$

$$W_c = 68.9\ T_c, \text{ and} \tag{61}$$

$$W_t = W_v + W_b + W_c \quad , \tag{62}$$

where

W_v, W_b, W_c, and W_t = weight of daily carbon intake via vegetables, meat, milk, and total intake, respectively

Table 2. Dose conversion factors for ^{14}C

Organ	Dose conversion factors[a] ($rem-cm^3/pCi-year$)
Whole body	1.16×10^3
Red marrow	2.03×10^3
Lungs	5.07×10^2
Endosteal cells	1.85×10^3
Stomach wall	7.43×10^2
Lower large intestine wall	8.92×10^2
Thyroid	5.27×10^2
Liver	7.30×10^2
Kidneys	6.49×10^2
Testes	4.46×10^2
Ovaries	4.46×10^2

[a] These factors are based on the assumption that the specific activity in human tissue is equal to the average steady state value in the atmosphere (Killough and Rohwer, 1978).

V = daily vegetable consumption (kg),

T_b = daily meat consumption (kg),

T_c = daily milk consumption (liters).

Normalization is accomplished by using weight fractions of ^{14}C for each food type in the dose equations:

$$D_v = CF_v\ (f_{v1}\chi + f_{v2}\chi_v) \quad , \tag{63}$$

$$D_b = CF_b\ (f_{b1}\chi + f_{b2}\chi_b) \quad , \text{ and} \tag{64}$$

$$D_c = CF_c\ (f_{c1}\chi + f_{c2}\chi_c) \quad , \tag{65}$$

where D_v, D_b, and D_c = ingestion dose for ^{14}C from vegetables, meat, and milk (rem/year);

C = dose conversion factor for ^{14}C (rem-cm^3/pCi-year);

F_v = weight fraction of ^{14}C from vegetables (W_v/W_t);

F_b = weight fraction of ^{14}C from meat (W_b/W_t);

F_c = weight fraction of ^{14}C from milk (W_c/W_t);

f_{v1} = fraction of vegetable intake which is produced at individual's environmental location;

f_{v2} = fraction of vegetable intake whose source represents an average produced over the assessment area;

f_{b1} = as above for f_{v1} except applied to meat;

f_{b2} = as above for f_{v2} except applied to meat;

f_{c1} = as above for f_{v1} except applied to milk;

f_{c2} = as above for f_{v2} except applied to milk;

χ = ground-level concentration of ^{14}C in air at individual's environmental location (pCi/cm^3);

χ_v = average ground-level concentration of ^{14}C in air over the assessment area weighted by quantities of vegetables produced as a function of location;

χ_b = as above for χ_v except applied to meat;

χ_c = as above for χ_v except applied to milk.

The total dose from ^{14}C is the sum of D_v, D_b, and D_c.

3.3.7 Environmental concentrations and intake rates

Health risks to man as a result of radiation exposures are not directly related to dose commitments, but are more closely correlated with environmental concentrations and rates of intake of radionuclides by ingestion and inhalation. To facilitate health risk estimations, DOSEN calculates and prints tables of the following for each radionuclide and specified environmental location: (1) concentration in air (curies per m^3); (2) ground concentration (curies per m^2), (3) ingestion intake rate (picocuries per year), and (4) inhalation intake rate (picocuries per year). In addition, these values are written as unformatted output so that they may be used as input data for computer assessments of health risks.

3.3.8 Working level calculations for ^{222}Rn

Working level (WL) is calculated for ^{222}Rn and its short-life progeny at each specified environmental location. One WL is defined as any combination of short-life progeny (^{218}Po, ^{214}Pb, ^{214}Bi, and ^{214}Po) in one liter of air that will release 1.3×10^5 MeV of alpha particle kinetic energy during decay to ^{210}Pb. The equation used (Evans, 1969) is

$$WL = 0.01\ S_eC \tag{66}$$

in which

C = concentration of ^{222}Rn in air (pCi/liter),

0.01 = conversion factor,

S_e = assumed fraction of equilibrium for short-life progeny.

The value of S_e is input in CONCEN as SEQWL. The default value is 0.7. Calculations of WL and printing of tables are done in subroutine DOSMIC.

3.3.9. Buildup of radioactive daughters on surfaces after deposition of a parent radionuclide

A radionuclide building up on ground surfaces or in water as a result of the deposition of its parent may contribute to doses from surface exposure, water immersion, and food ingestion. To calculate this effect, the daughter should be added to the source term with a zero release rate if it is not also released to the atmosphere at the source. Input parameters for the daughter are supplied as follows: I1, I2, I3, I4, and I5 (integer indices for one to as many as five parent radionuclides in the source term) and F1, F2, F3, F4, and F5 (buildup factors for each parent). The F factor is defined as the surface input rate of the daughter from parent decay per unit aerial deposition rate of the parent.

The total surface input rate from buildup of a daughter is the sum of the products of each F value multiplied by the aerial deposition rate of the parent. This sum added to the aerial deposition rate of the daughter, d_i, is d_{ieff}, the effective surface input rate.

The value of d_{ieff} is used to calculate surface and water concentrations after buildup time t_b. The use of d_{ieff} for ingestion intake is more complicated and requires the use of a modified version of Eq. (49) for calculating the concentration $C_i^V(r, \theta)$ of a nuclide in and on vegetation. The appropriate equation is

$$C_i^V(r, \theta) = d_i(r, \theta) \frac{R[1 - \exp(-\lambda_{Ei} t_e)]}{Y_v \lambda_{Ei}} +$$

$$d_{ieff}(r, \theta) \; B_{iv} \frac{[1 - \exp(-\lambda_i t_b)]}{P \lambda_i} \; \exp\,(\lambda_i t_h) \quad . \qquad (67)$$

4. USE OF THE CODE

Options available to the user and data requirements are described below.

4.1 Options Available to the User

4.1.1 Options in the main program (MAIN)

The options available in MAIN are applied to subroutines CONCEN and DIRECT. Option (1) specifies the flow of the code. If option (1) = 0, CONCEN is called to estimate concentrations of the radionuclides in air and rates of deposition on ground surfaces, and then subroutine DOSEN is called to calculate doses to man, environmental concentrations, and intake rates. If option (1) = 1, however, the program is terminated after completion of the calculations in CONCEN. If it is desired to calculate doses and intake rates directly from input values of radionuclide concentrations in air and ground deposition rates, option (1) is specified as 2. MAIN will then call subroutine DIRECT, which reads the required input data, and then it will call DOSEN.

Option (2) determines whether a square grid environmental configuration [option (2) = 0] or a circular configuration [option (2) = 1] are used in the assessment.

Option (3) determines whether the values calculated by CONCEN will represent averages over sectors of 22.5° [option (3) = 0] or will represent the centerline of a plume [option (3) = 1].

Option (4) determines how plume rise is calculated. If option (4) = 0, Briggs' equations for buoyant plumes are used. If option (4) = 1, Rupp's equation for momentum-type emissions is used. Specific values for plume rise for each Pasquill atmospheric stability category can be entered as input data if option (4) is specified as 2.

Option (5) allows the user to vary the deposition velocity of each radionuclide in the source term with the direction and distance from the plant. This option is invoked if option (5) = 1 and if the circular configuration [i.e., option (2) = 1] is used.

Option (6) is an integer value from 0 to a maximum of 36 which specifies the number of radionuclides in the source term for which concentrations in air and rates of deposition on ground surfaces are punched on cards. For example, if option (6) = 4 and there are 16 radionuclides in the source term, concentrations and deposition rates will be punched for the first four radionuclides in the list.

Option (7) is specified as 1 if the radionuclides in the source term are assumed to be released uniformly from a circular area such as from a tailings pile of a uranium mill. The reference point for environmental locations is the center of the circular area. If option (7) = 0, a point release is assumed.

The user can eliminate the printing of the main output table of CONCEN, which lists estimated concentrations in air and ground deposition rates in the environment, by setting option (8) = 1. If option (8) = 0, then the table is printed.

A table of χ/Q values for each radionuclide in the source term is normally printed by subroutine CHIQ called by CONCEN if the assessment area is circular, but the user can eliminate these tables from the output by setting option (9) = 1. If option (9) = 0, then the tables are printed.

Details of options selected in MAIN are given below.

4.1.1.1 The circular option. For this option, the area around the plant is divided into sixteen 22.5° sectors emanating from the release point. The midpoint of each sector is one of sixteen compass directions numbered 1 through 16 starting with direction 1 for due north and proceeding counterclockwise to NNE for direction 16. As many as 20 distances are entered as input data to represent midpoints of environmental locations for all sectors.

The parameter SQSD in Subroutine CONCEN sets the length of a side of each of the 400 grid squares for the square grid option discussed in Sect. 4.1.1.2. A value for this parameter must also be selected for the circular option because it is used in the code in a statement testing the importance of radiological decay during plume travel. The SQSD value should be approximately equal to 0.1 of the radius of the circular assessment area.

4.1.1.2 The square grid option. If the square grid option is selected in the main program, the code will estimate concentrations in air and ground deposition rates at the midpoints of each of 400 square grids in a 20 by 20 array with the release point located at the center. The array is aligned north-south and east-west with the abscissa numbers going from 1 to 20 from west to east and with the ordinate numbers going from 1 to 20 from south to north. An input parameter SQSD sets the length of the side of each of the 400 grid squares.

The code computes concentrations by starting at grid (1, 1) and proceeds through grid (1, 20), and then goes to (2, 1), proceeds to (2, 20), and continues this process through grid (20, 20). For each grid square, the center of the square is identified as within one of 16 sectors emanating from the release point by reference to a data statement within the computer code. The compass directions at the midpoints of each of these 22.5° sectors are numbered from 1 to 16 starting with 1 for due north and proceeding counterclockwise through direction 16. Downwind distance is calculated from the grid identifiers and the value of SQSD.

The very poor resolution for the area near the plant afforded by the preceding procedure is improved within the computer code by recomputing concentrations for the innermost 16 grid squares. This 16-grid area is converted into a 20 by 20 grid; the concentration in each of the 16 inner grid squares is then computed as the average value for 25 uniformly distributed smaller grid squares.

The square grid configuration has an advantage over the circular configuration in that the environmental areas are more compact and, hence, are more amenable to discrete characterization. A more important consideration, however, is that concentration values in a square grid arrangement can be more readily adapted to multiple point source or area source assessments.

4.1.1.3 Option for varying deposition velocity. An input value for dry deposition velocity is entered for each radionuclide in the source term. In a normal computer run, this value is used to estimate the rate of dry deposition of the radionuclide on ground or water surface and the resulting depletion of the plume for all directions and distances from the plant. This procedure is adequate for areas with relatively uniform environmental characteristics, but it may be inaccurate for areas consisting of a wide variety of surfaces such as tall grass, forests, or lakes. There may be as much as an order of magnitude difference in deposition velocity between bare soil and forest canopy (Sehmel et al., 1973), for example, and this may lead to considerable differences in air concentrations downwind of a forest versus a bare-soil region.

To assess non-uniform areas more realistically, the user of the code may elect through option (5) to use a different value for deposition velocity for each environmental location identified by direction and distance from the plant. This option is available only for the circular configuration [i.e., option (2) = 1] because integration of plume depletion equations must proceed outward from the plant for each direction and cover each environmental location in stepwise fashion. For this option, multiplier parameters for each environmental location specified by direction and distance and upper and lower bounds for distances must be added to the input data. The deposition velocity for each radionuclide within a specific environmental location is the product of the initial deposition velocity entered for the radionuclide and the multiplier for the location.

4.1.1.4 The area source option. For this option, the source is assumed to be an area such as a tailings pile with a uniformly distributed rate of release of radionuclides. The dispersion treatment is described in Sect. 3.2.9. The diameter in meters of a circle of the same area as the source must be entered as input in CONCEN to use this option. If this value is less than 10 m, however, the area source is treated as a point source.

4.1.2 Optional features of subroutine CONCEN

The first data input of CONCEN are specifications of lower and upper bounds for grid abscissa and ordinate as integer values for NOL, NOU, NRL, and NRU. Normally, for the square grid option, the abscissa limits are NOL = 1 and NOU = 20, going from west to east, and the ordinate limits are NRL = 1 and NRU = 20, going from south to north. The user can, however, specify higher values for NOL and NRL or lower values for NOU and NRU for special applications. Integers for NOL to NOU are column numbers, and integers for NRL to NRU are row numbers. The circular option requires that NOU must not exceed 16 as an upper bound for column numbers because only 16 compass directions are involved. The numbering starts at NOL = 1 for due north and proceeds counterclockwise to 16 for NNE. The row numbers for the circular option (NRL to NRU), which may range from 1 to 20, refer to distances in meters from the source, which are supplied by the user as integer values of the IDIST input parameter.

If the square grid option is selected in the main program, the grid size is specified in CONCEN as the value SQSD, the length of the side of the grid squares in meters. A value of 8000 m for SQSD produces a square assessment area superscribing a circle with a radius of 50 miles.

For the circular configuration, the number of distances from the plant in each compass direction (IDIST values) should be equal to the value of NRU.

The assessment area for which doses and intake rates are calculated in DOSEN is identical to that defined by the bounds set in CONCEN. The agricultural and population input data entered in DOSEN in 20 by 20 arrays should contain 0 values for all elements of these arrays lying outside the bounds of the assessment area.

4.1.3. Options and optional features of subroutine DOSEN

The first input data for DOSEN are six options. The first, LIPO, is a specification as to whether the calculations are to be made for the maximally exposed individual (LIPO = 0) or for the population in the area (LIPO = 1).

The second option (NNTB) determines the number of tables to be printed listing doses by grid location, exposure mode and organ by individual radionuclide. Each of these tables is lengthy, and it is usually desirable to minimize the printed output by specifying NNTB = 0.

Doses by radionuclide, organ, and pathway are punched on cards if option (3), NRTB, is specified as 1. If NRTB = 0, punching of these values is omitted.

If option (4), NSTB, is 1, concentrations in air, ground concentrations, ingestion intake rates, and inhalation intake rates by man for each environmental location for each radionuclide except ^{222}Rn are printed and written as unformatted output. If NSTB = 0, output of these values is omitted. Working levels for ^{222}Rn are outputted if NSTB = 1 and omitted if NSTB = 0.

The fifth and sixth options, NTTB and NUTB, control calculations and printing by DOSMIC. Dose summary tables are printed if NTTB = 1 and omitted if NTTB = 0. Working levels for ^{222}Rn are calculated and tabulated if NUTB = 1 but omitted if NUTB = 0.

In addition to the six specified options above, there are several options available to the user for treating ingestion. The parameters RVEG, RBEF, and RMLK for vegetables, meat, and milk specify the ratio of the quantity of each type of food ingested by a person that is produced at his environmental location to the sum of that produced at his location and the quantity that he ingests that is produced throughout the entire assessment area. The radionuclide content of each of the three food types produced throughout the entire assessment area is a weighted average over the grid system. The assessment area is bounded by the integers NOL, NRL, NOU, and NRU in a 20 by 20 grid system. Therefore, quantities of food produced (and human population) should be listed as 0 for all locations lying outside of these bounds.

The *minimum* fractions of each of the individual's intake of each food type that comes from outside of the assessment area altogether, and assumed to be uncontaminated, are specified as F3VEGM, F3BEFM, and F3MLKM. The code can compute a higher imported fraction for each food type if required to meet nutritional requirements as specified in the input data. The user can fix the minimum imported fractions to be *actual* fractions by setting IMPFIX = 1.

Fallout interception fractions for pasture grasses and fresh vegetables consumed by man are designated R1 and R2, respectively. These factors are applied to all radionuclides, but may be optionally changed for any specific radionuclide by setting IFLAG, normally 0, at 1 or 2. If IFLAG = 1, special parameters RD1 and RD2 are used instead of R1 and R2. If IFLAG = 2, RD1 and RD2 are used for dry deposition, and RW1 and RW2 are used for wet deposition.

4.2 Data Input and Example Run

The listing of the AIRDOS-EPA COMPUTER CODE IN Appendix A identifies the order and format of the input parameters in the READ statements and their corresponding FORMAT statements. Parameter names and their definitions and units are listed in Tables 3, 4, 5, and 6 for the main program and subroutines CONCEN, DIRECT, and DOSEN, respectively. Table 7 lists the parameters from these tables with their data card formats.

Appendix B is the output of an example run of the code.

Table 3. Input parameters for main program

Name	Number of values	Definition	
WORD	1	the word OPTIONS	
OPTION	9	Option (1)	0 to run the entire code
			1 if it is desired to run only subroutine CONCEN
			2 if subroutine DIRECT is to be called instead of CONCEN
		Option (2)	0 for the 20 by 20 square grid configuration
			1 for the circular configuration
		Option (3)	0 for sector-averaged computations
			1 for plume centerline computations
		Option (4)	0 to compute plume rise for buoyant plumes using Briggs' equations
			1 to compute plume rise for momentum-type emissions by Rupp's equation
			2 to use specific values for plume rise entered as input data for each Pasquill atmospheric stability category
		Option (5)	0 if deposition velocity is not varied with direction and distance for each radionuclide
			1 if deposition velocity varies with direction and distance [may only be used if option (2) = 1]
		Option (6)	An integer from 0 to 36 specifying the number of radionuclides in the source term for which air concentrations and ground deposition rates are punched on cards

Table 3. (continued)

Name	Number of values	Definition
		Option (7) 0 for point-source atmospheric dispersion calculations
		1 for calculations for a uniform circular area source
		Option (8) 0 to print the main output table of CONCEN
		1 to omit printing the above
		Option (9) 0 to print χ/Q tables
		1 to omit χ/Q tables

Table 4. Input parameters for subroutine CONCEN

Name	Number of Values	Definition	Units
NOL	1	Lower grid limit (abscissa)	
NOU	1	Upper grid limit (abscissa)	
NRL	1	Lower grid limit (ordinate)	
NRU	1	Upper grid limit (ordinate)	
PR	7	Specific plume rise for each Pasquill category	meters
WORD	1	The word AREA	
SQSD	1	The exact length of the side of each grid square when using the square grid configuration. A value for SQSD must also be used for the circular option which corresponds to the approximate length of each grid square in a 20 by 20 grid superscribed on the circular assessment area	meters
SEQWL (S_e)	1	Assumed fraction of equilibrium for the short-life progeny of ^{222}Rn (default value = 0.7)	
IDIST	20	Distances from plant to be used with circular option	meters
WORD	1	The word AIR	
LIDAI (L)	1	Height of lid	meters
RR	1	Rainfall rate in area	centimeters/year
TA	1	Average air temperature in area	°K
TG	3	Vertical temperature gradient for Pasquill categories E, F, and G	°K/meter
PERD	16	Wind direction frequency (16 directions)	

Table 4. (Cont'd)

Name	Number of values	Definition	Units
UDCAT (μ_r)	112	Reciprocal-averaged wind speeds (7 Pasquill categories, 16 directions)	meters/sec
UDAV (μ_a)	112	True-average wind speeds (7 Pasquill categories, 16 directions)	meters/sec
FRAW	112	Frequencies for Pasquill stability categories (each of 16 directions)	
WORD	1	The word STACKS	
NUMST	1	Number of stacks or release areas	
PH (h)	NUMST	Physical height of stack	meters
DIA (d)	NUMST	Diameter of stack	meters
VEL (v)	NUMST	Velocity of stack gases	meters/sec
QH (Q_h)	NUMST	Heat release from stack	cal/sec
DIM	NUMST	Diameter of area source	meters
WORD	1	The word NUCLIDES	
NNUCS	1	Number of nuclides in source term	
NAMNUC	NNUCS	Name of nuclide, such as I-131 or RU-103	
ANLAM	NNUCS	Effective radiological decay constant in the plume	day^{-1}
SC (Φ)	NNUCS	Scavenging coefficient	sec^{-1}
VD (V_d)	NNUCS	Dry deposition velocity	meters/sec
VG (V_g)	NNUCS	Gravitational (or settling) velocity	meters/sec
REL (Q)	NNUCS x NUMST	Release rate of radionuclide from stack	curies/year

Table 4. (Cont'd)

Name	Number of values	Definition	Units
BOUND	20	First value is upper bound of area represented by first IDIST value and lower bound of area represented by second IDIST value, and continuing for all 20 possible IDIST values [BOUND values and subsequent VDCOEF and LIST values are to be entered only if Option (5) = 1]	meters
VDCOEF	(NOU-NOL+1) X(NRU-NRL+1)	Factor to be multiplied by VD to give dry deposition velocity representative of the area for a specific compass direction and IDIST value	
LIST	20	0 to print concentrations for distance corresponding to IDIST 1 to suppress printing for IDIST distance	

Table 5. Input parameters for subroutine DIRECT

Name	Number of values	Definition	Units
NOL	1	Lower grid limit (abscissa)	
NOU	1	Upper grid limit (abscissa)	
NRL	1	Lower grid limit (ordinate)	
NRU	1	Upper grid limit (ordinate)	
SQSD	1	The length of the side of each grid square if input air concentrations and ground deposition rates are for a square grid configuration	meters
IDIST	20	Distances from point of release or center of circular area source for a circular configuration	meters
SEQWL (S_e)	1	Assumed fraction of equilibrium for the short-life progeny of ^{222}Rn (default value = 0.7)	
NNUCS	1	Number of nuclides in source term	
NAMNUC	NNUCS	Name of nuclide	
VD (V_d)	NNUCS	Dry deposition velocity	meters/sec
SC (ϕ)	NNUCS	Scavenging coefficient	sec^{-1}
ACON (X)	400	Concentration in air at ground level for each environmental location (input in a 20 by 20 array)	picocuries/cm^3
GCON (R_t)	400	Rate of deposition on ground surface for each environmental location (input in a 20 by 20 array)	picocuries/cm^2-sec

Table 6. Input parameters for subroutine DOSEN

Name	Number of values	Definition	Units
LIPO	1	Option — 0 for individual dose, 1 for population dose	
NNTB	1	Number of individual radionuclide dose tables by grid location and pathway to be printed. Used to suppress printing	
NRTB	1	Option — 1 for punching on cards doses by nuclide, organ and pathway, 0 for omitting the above	
NSTB	1	Option — 1 for printing and unformatted output of environmental concentrations and intake rates by man for each nuclide, 0 for omitting the above	
NTTB	1	Option — 1 for printing dose summary tables, 0 for omitting the above	
NUTB	1	Option — 1 for printing of working levels for ^{222}Rn if it is in the source term, 0 for omitting the above	
NOBCT	400	Number of meat producing animals for each environmental location (input in a 20 by 20 array)	
NOMCT	400	Number of dairy cattle for each environmental location (input in a 20 by 20 array)	
INTFC	400	Area of vegetable crop production for each environmental location (input in a 20 by 20 array)	m^2
INTPA	400	Population for each environmental location (input in a 20 by 20 array)	
INTWA	400	Identification as to whether an environmental location contains significant water areas (0 or 1) (input in a 20 by 20 array)	
IMPFIX	1	The integer 1 fixes the fraction of each food type imported into the assessment area at the minimum fraction specified as F3VEGM, F3BEFM, and F3MLKM defined below	

Table 6. (continued)

Name	Number of values	Definition	Units
RVEG	1	The fraction representing the quantity of ingested vegetables produced at the environmental location divided by the total quantity ingested which is produced throughout the assessment area including the quantity ingested which is produced at the environmental location	
F3VEGM	1	The minimum fraction of ingested vegetables which is imported into the assessment area. The code may compute a higher value to be used unless IMPFIX = 1	
RBEF	1	Same as RVEG except applied to meat	
F3BEFM	1	Same as F3VEGM except applied to meat	
RMLK	1	Same as RVEG except applied to milk	
F3MLKM	1	Same as F3VEGM except applied to milk	
BRTHRT (B_r)	1	Breathing rate of man	cm^3/hr
DILFAC (d)	1	Depth of water to be used for water immersion doses	centimeters
USEFAC	1	Fraction of time spent swimming	
T (t)	1	Buildup time allotted for surface deposition	days
DD1	1	Fraction of radioactivity retained on leafy vegetables and produce after washing	
TSUBH1 (t_{h1})	1	Time delay – ingestion of pasture grass by animals	hr
TSUBH2 (t_{h2})	1	Time delay – ingestion of stored feed by animals	hr
TSUBH3 (t_{h3})	1	Time delay – ingestion of leafy vegetables by man	hr
TSUBH4 (t_{h4})	1	Time delay – ingestion of produce by man	hr
LAMW (λ_w)	1	Removal rate constant for physical loss by weathering	hr^{-1}

Table 6. (continued)

Name	Number of values	Definition	Units
TSUBE1 (t_{e1})	1	Period of exposure during growing season — pasture grass	hr
TSUBE2 (t_{e2})	1	Period of exposure during growing season — crops or leafy vegetables	hr
YSUBV1 (Y_{v1})	1	Agricultural productivity by unit area (grass-cow-milk-pathway)	kg/m^2
YSUBV2 (Y_{v2})	1	Agricultural productivity by unit area (produce or leafy vegetables)	kg/m^2
FSUBP (f_p)	1	Fraction of year animals graze on pasture	
FSUBS (f_s)	1	Fraction of daily feed that is pasture grass when animals graze on pasture	
QSUBF (Q_F)	1	Consumption rate of contaminated feed or forage by an animal (dry weight)	kg/day
TSUBF (t_f)	1	Transport time from animal feed-milk-man	days
UV ($U_{ap}{}^V$)	1	Rate of ingestion of produce by man	kg/year
UM ($U_{ap}{}^M$)	1	Rate of ingestion of milk by man	liters/year
UF ($U_{ap}{}^F$)	1	Rate of ingestion of meat by man	kg/year
UL ($U_{ap}{}^L$)	1	Rate of ingestion of leafy vegetables by man	kg/year
TSUBS (t_s)	1	Average time from slaughter of meat animal to consumption	days
FSUBG (f_g)	1	Fraction of produce ingested grown in garden of interest	
FSUBL (f_ℓ)	1	Fraction of leafy vegetables grown in garden of interest	
TSUBB (t_b)	1	Period of long-term buildup for activity in soil	years
P	1	Effective surface density of soil (dry weight) (assumes 15-cm plow layer)	kg/m^2

Table 6. (continued)

Name	Number of values	Definition	Units
TAUBEF	1	Fraction of meat producing herd slaughtered per day	
MSUBB	1	Muscle mass of meat producing animal at slaughter	kilograms
VSUBM	1	Milk production of cow	liters/day
R1 (R_1)	1	Fallout interception fraction for pasture	
R2 (R_2)	1	Fallout interception fraction for vegetable crops	
NUMORG	NNUCS	Number of organs considered for the radionuclide	
LAMRR (λ_i)	NNUCS	Radioactive decay constant for the radionuclide	day^{-1}
CFSBA (C_{imm})	NNUCS	Skin dose conversion factor for submersion in air	$\text{rem-cm}^3/\mu\text{Ci-hr}$
CFSBW (C_{wimm})	NNUCS	Skin dose conversion factor for submersion in water	$\text{rem-cm}^3/\mu\text{Ci-hr}$
CFSUR (C_{surf})	NNUCS	Skin dose conversion factor for surface exposure	$\text{rem-cm}^2/\mu\text{Ci-hr}$
KFLAG	NNUCS	Usually 0; a value of 1 is used for a radionuclide which is a daughter product assumed to have an effective decay constant in the plume (ANLAM) equal to the decay constant of its longer-lived parent, and it is desired to use the ANLAM value to calculate its decay on ground surfaces and in water instead of its true decay constant, LAMRR	
TDCF (C_f)	NNUCS	Dose conversion factor for food; always 0 except for tritium	$\text{rem-cm}^3/\text{pCi-year}$
TDCW (C_w)	NNUCS	Dose conversion factor for drinking water; always 0 except for tritium	$\text{rem-cm}^3/\text{pCi-year}$
FROG	NNUCS X 11	Dose correction factors for whole body and each reference organ to multiply by external doses for skin. The order of the organs is given under NAMORG in this table	

Table 6. (continued)

Name	Number of values	Definition	Units
FSUBMI (F_m)	NNUCS	Average fraction of animal's daily intake of nuclide which appears in each liter of milk	days/liter
FSUBFI (F_f)	NNUCS	Fraction of animal's daily intake of nuclide which appears in each kg of flesh	days/kg
BSUBV1 (B_{iv1})	NNUCS	Concentration factor for uptake of nuclide from soil for pasture and forage (pCi/kg dry weight per pCi/kg dry soil)	
BSUBV2 (B_{iv2})	NNUCS	Concentration factor for uptake of nuclide from soil by edible parts of crops (pCi/kg wet weight per pCi/kg dry soil)	
LAMSUR (λ_w)	NNUCS	Environmental decay constant for surface for the radionuclide	day^{-1}
LAMH2O	NNUCS	Environmental decay constant for water areas for the radionuclides	day^{-1}
IFLAG	NNUCS	0 for a normal run; 1 if special values RD1 and RD2 are to be used instead of R1 and R2. 2 if special values RD1 and RD2 for dry deposition processes and special values RW1 and RW2 for wet deposition (scavenging) processes are to be used.	
RD1 (RD_1)	NNUCS	Special value for R1 as defined for IFLAG	
RD2 (RD_2)	NNUCS	Special value for R2 as defined for IFLAG	
RW1 (RW_1)	NNUCS	Special value for R1 as defined for IFLAG	
RW2 (RW_2)	NNUCS	Special value for R2 as defined for IFLAG	

Table 6. (continued)

Name	Number of values	Definition	Units
ISOL	NNUCS	Solubility class for nuclide D = days W = weeks Y = years	
AMAD	NNUCS	Particle size for nuclide	µ
F1INH	NNUCS	Gastrointestinal uptake fraction for inhalation	
I1	1	Index integer for a parent radionuclide contributing to surface buildup	
I2	1	As above for a second parent	
I3	1	As above for a third parent	
I4	1	As above for a fourth parent	
I5	1	As above for a fifth parent	
F1	1	Surface input rate for the nuclide resulting from decay of parent I1 per unit aerial deposition rate of I1	
F2	1	As above except for parent I2	
F3	1	As above except for parent I3	
F4	1	As above except for parent I4	
F5	1	As above except for parent I5	
NAMORG	NUMORG X NNUCS	Name of organ, to be written as follows: TOT.BODY (for whole body), R MAR, LUNGS, ENDOST, S WALL, LLI WALL, THYROID, LIVER, KIDNEYS, TESTES, OVARIES	
CFINHA	NUMORG X NNUCS	Dose conversion factor for the organ for inhalation	rem/µCi
F1ING	NUMORG X NNUCS	Gastrointestinal uptake fraction for ingestion	
CFINGA	NUMORG X NNUCS	Dose conversion factor for the organ for ingestion	rem/µCi

Table 7. Data deck preparation for AIRDOS-EPA

Parameters	Number of values	Number of cards	Data type	Format
		Main program		
WORD, OPTION	1 for WORD, 9 for OPTION	1	WORD=OPTIONS OPTIONS values-integer	A8,5I1,I2,3I1
		Subroutine CONCEN		
NOL,NOU,NRL,NRU	1 for each parameter	1	Integer	8I10
PR	7	1	Fixed point	8F10.0
WORD	1	1	WORD=AREA	A8
SQSD	1	1	Fixed point	8F10.0
SEQWL	1	1	Fixed point	F10.0
IDIST	20	3	Integer	8I10
WORD	1	1	WORD=AIR	A8
LIDA1	1	1	Integer	8I10
RR,TA,TG	1 for RR, 1 for TA, 3 for TG	1	Fixed point	8F10.0
PERD	16	1	Fixed point	16F5.0
UDCAT	112	7	Fixed point	16F5.0
UDAV	112	7	Fixed point	16F5.0
FRAW	112	16	Fixed point	7F10.0

Table 7. (Continued)

Parameters	Number of values	Number of cards	Data type	Format	
WORD	1	1	WORD=STACKS	A8	
NUMST	1	1	Integer	8I10	
PH,DIA,VEL,QH,DIM	(1 for each parameter) x value of NUMST	Value of NUMST	Fixed point	8F10.0	
WORD	1	1	WORD=NUCLIDES	A8	
NNUCS	1	1	Integer	8I10	
NAMNUC	1	1	Alphameric	A8	*a*
ANLAM,SC,VD,VG	1 for each parameter	1	Fixed point	8F10.0	
REL	Value of NUMST	1	Fixed Point	8F10.0	
BOUND	20	3	Fixed point	8F10.0	
VDCOEF	(NOU-NOL + 1) x (NRL-NRU + 1)	Number required for a maximum of 10 values per card	Fixed point	10F8.4	*b*
LIST	20	1	Integer	20I1	
		Subroutine DIRECT			
NOL,NOU,NRL,NRU	1 for each parameter	1	Integer	8I10	
SQSD	1	1	Fixed point	8F10.0	
IDIST	20	3	Integer	8I10	
SEQWL	1	1	Fixed point	F10.0	
NNUCS	1	1	Integer	8I10	
NAMNUC,VD,SC	1 for each parameter	1	Alphameric, fixed point, floating point	A8 F12.4 E10.3	*c*
ACON	400	50	Floating point	8E10.3	
GCON	400	50	Floating point	8E10.3	

Table 7. (Continued)

Parameters	Number of values	Number of cards	Data type	Format
		Subroutine DOSEN		
LIPO	1	1	Integer	5I10
NNTB,NRTB,NSTB,NTTB, NUTB	1 for each parameter	1	Integer	5I10
NOBCT	400	25	Integer	16I5
NOMCT	400	25	Integer	16I5
INTFC	400	50	Floating point	8E10.3
INTPA	400	50	Fixed point	8F10.1
INTWA	400	10	Integer	40I2
IMPFIX	1	1	Integer	I10
RVEG,F3VEGM,RBEF, F3BEFM,RMLK,F3MLKM	1 for each parameter	1	Fixed point	6F10.3
BRTHRT,DILFAC, USEFAC,T,DD1	1 for each parameter	1	Fixed point	6F10.3
TSUBH1,TSUBH2, TSUBH3,TSUBH4	1 for each parameter	1	Floating point	8E10.3
LAMW	1	1	Floating point	8E10.3
TSUBE1,TSUBE2	1 for each parameter	1	Floating point	8E10.3
YSUBV1,YSUBV2	1 for each parameter	1	Floating point	8E10.3
FSUBP	1	1	Floating point	8E10.3
FSUBS	1	1	Floating point	8E10.3
QSUBF	1	1	Floating point	8E10.3

Table 7. (Continued)

Parameters	Number of values	Number of cards	Data type	Format	
TSUBF	1	1	Floating point	8E10.3	
UV,UM,UF,UL	1 for each parameter	1	Floating point	8E10.3	
TSUBS	1	1	Floating point	8E10.3	
FSUBG,FSUBL	1 for each parameter	1	Floating point	8E10.3	
TSUBB	1	1	Floating point	8E10.3	
P	1	1	Floating point	8E10.3	
TAUBEF,MSUBB,VSUBM	1 for each parameter	1	Fixed point	10F8.4	
R1,R2	1 for each parameter	1	Fixed point	10F8.4	
NUMORG,LAMRR,CFSBA, CFSBW,CFSUR,KFLAG, TDCF,TDCW	1 for each parameter	1	Integer and floating point	I10,4E10.3, I10,2E10.3	*d*
FROG	11	1	Fixed point	11F5.3	
FSUBMI,FSUBFI,BSUBV1, BSUBV2	1 for each parameter	1	Floating point	8E10.3	
LAMSUR,LAMH2O,IFLAG, RD1,RD2,RW1,RW2	1 for each parameter	1	Floating point, integer, and fixed point	2E10.3,I1, 6F8.4	
I1,I2,I3,I4,I5,F1,F2, F3,F4,F5	1 for each parameter	1	Integer and floating point	5I4,5E10.3	
ISOL,AMAD,F1INH	1 for each parameter	1	Alphameric and floating point	T11,A1,T15, E10.3,T27, E10.3	
NAMORG,CFINHA	1 for each parameter x value of NUMORG	NUMORG	Alphameric and floating point	A8,T10,E10.3	
F1ING	1	1	Floating point	T11,E10.3	
CFINGA	Value of NUMORG	NUMORG	Floating point	T11,E10.3	

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[a] A set of the three cards in this bracket is required for each radionuclide. The number of these sets of cards must be equal to the value of NNUCS.

[b] The cards in the bracket for BOUND, VDCOEF, and LIST should not be included in the data deck unless OPTION (5) = 1.

[c] A set of the cards in this bracket is required for each radionuclide. The total number of these sets is the value of NNUCS.

[d] One set of cards in this bracket is required for each radionuclide. Each set is referred to as the radionuclide data deck for the specific radionuclide. The number of radionuclide data decks must be equal to the value of NNUCS. The set of cards for NAMORG, CFINHA, FIING, and CFINGA for each radionuclide is referred to as the organ data deck for the specific radionuclide.

5. TERRESTRIAL TRANSPORT INPUT PARAMETERS

The parameter values listed in the following sections have been used in the demonstration computer run given in Appendix B. For the parameters B_{iv}, F_m, and F_f, a review of original references is currently being performed. The values listed for these parameters reflect the *current* status of this review. The listed values will undoubtedly change as new references are reviewed or become available. Many of the other parameter values listed are derived from the extensive and well-documented reviews by Ng et al. (1977) and Hoffman and Baes (1979). A statistical distribution has been described for many of the parameters reviewed by Hoffman and Baes (1979), and the values taken from this review and listed in this section are the mean values with respect to the distribution described for the parameter.

The values listed for the soil-plant bioaccumulation factor B_{iv}, the forage-to-milk transfer coefficient F_m, and the forage-to-meat transfer coefficient F_f were derived from a review of original experimental data according to the methodology described below. Individual observations or the average of replicate observations (whichever given by the author) specific for the parameter were taken from the reference. When necessary, reported B_{iv} data were transformed to adhere to the strict definitions of the parameter by using appropriate fresh weight-dry weight conversion factors (Morrison, 1956; Spector, 1956). Ingestion rates given by Liden and Gustafsson (1967) and Bell (1978) were used to derive some values of F_f from associated meat and forage data. All measurements applicable to the parameter in a reference were used to calculate an arithmetic mean value for that reference. Finally, the values for each reference were used to derive an unweighted arithmetic mean for all references combined. This final value, unless otherwise noted, is the value listed for the parameter.

The parameters used in the terrestrial transport models in Sect. 3 are designed to represent annually averaged values at equilibrium over a wide range of environmental conditions. Empirical data used in deriving values for these parameters may not always reflect annual average or equilibrium conditions. In addition, data from laboratory or otherwise-controlled experiments which do not adequately simulate field conditions may lead to erroneous evaluations for specific assessment sites. Furthermore, empirical data may not adequately reflect the true distribution of values associated with each parameter under various conditions. Thus, caution should be used in the interpretation of parameter values presented and results generated by the sample run.

5.1 Agricultural Productivity by Unit Area Y_v

In this report agricultural productivity, in kilograms per square meter, is given in dry weight for the above-ground portion of pasture grasses Y_{v1} and in fresh weight for the edible portions of leafy vegetables and produce ingested directly by man Y_{v2}. Since dry weight measurements of productivity for pasture grasses are most commonly found in the literature, direct comparison with productivity estimates for stored feeds and silage can be made. Fresh weight productivity estimates for leafy vegetables and produce consumed directly by man are appropriate because data on human food consumption is generally given in fresh weight. In addition, modern packaging and refrigeration techniques are designed to reduce desiccation and present a product as similar to harvest condition as possible. Table 8 presents mean values of Y_{v1} and Y_{v2} derived from the review and analysis of agricultural productivity by Baes and Orton (1979).

5.2 The Fraction of Atmospherically Depositing Radionuclides Intercepted by Above-Ground Portions of Plants R

The fraction of atmospherically depositing radionuclides intercepted and initially retained on above-ground portions of either forage crops or leafy vegetables and fresh produce ingested by man is symbolized by R_1 and R_2, respectively, where R_1, $R_2 \leq 1$. It is assumed in the model that unedible portions of vegetable crop plants are plowed into the soil at harvest.

5.2.1 Interception fraction R_1 for forage crops

Caution must be exercised when selecting a value of R_1 for assessment purposes because a correlation between R and Y_v has been demonstrated for forage crops (Chamberlain, 1970; Miller, 1979b). This correlation is likely because the fraction of an atmospherically depositing nuclide intercepted by a plant is highly dependent on the surface area available for interception. For forage crops, the available surface area or leaf area index is highly correlated to the above-ground standing crop biomass or productivity Y_{v1}.

Miller (1979a) analyzed associated measured values of R and Y_v and described a distribution for the ratio R/Y_v based on lognormal statistics. The resulting distribution of this ratio has been used in the present report to derive an arithmetic mean value of $R_1 = 0.57$. This R_1 value has been determined such that when combined with the mean Y_{v1} value of 0.28 (Table 8) the resultant ratio of R_1/Y_{v1} numerically equals the mean value (2.03) of the distribution of R/Y_v described by Miller (1979a).

5.2.2 Interception fraction R_2 for leafy vegetables and fresh produce

The correlation which Chamberlain (1970) demonstrated between R and Y_v is specific for pasture grasses. Such a relationship is not expected to exist for all leafy vegetables and fresh produce ingested by man for the following considerations:

1. On a weight basis, the edible portion of vegetable plants varies by species from nearly 100% for leafy vegetables to a very small fraction for food grains;
2. Surface area-to-weight ratios differ greatly among various types of vegetables; and
3. Edible portions of some vegetables are enclosed by tissue layers and fail to intercept atmospheric radionuclides (i.e., corn, peas, etc.).

Measurements of the interception fraction R_2 specific for edible portions of leafy vegetables and fresh produce ingested directly by man are unavailable. It is expected that the value of R_2 will be less than that of R_1 since most vegetable crops are usually cultivated in rows. On a unit area basis, this spacing of vegetable crops exposes more surface soil than the dense spacing of most forage crops. Booth et al. (1971) recognized this problem in their terrestrial model TERMOD and set the interception fraction value for fresh produce and vegetable crops lower than that for grasses. However, the magnitude of the actual difference between R_1 and R_2 is speculative. The R_2 value of 0.2 used by the NRC (U.S. Nuclear Regulatory Commission Regulatory Guide 1.109,

Table 8. Estimated values of above-ground agricultural productivity for forage grasses and edible portions of vegetable crops

Parameter	Mean Value[a] (kg/m^2)
Y_{v1} measured in dry weight (forage grasses)	0.28
Y_{v2} measured in fresh weight (leafy vegetables)[b]	1.9
Y_{v2} measured in fresh weight (non-leafy vegetables)[c]	0.57

[a] The mean estimates given above are the inverse of values derived by Baes and Orton (1979) for estimates of $1/Y_v$ based on experimental data.

[b] Y_{v2} for leafy vegetables is based on edible portions of cabbage, lettuce, and spinach.

[c] Y_{v2} for nonleafy vegetables is based on edible portions of broccoli, cauliflower, green peas, lima beans, and sweet corn.

1977) is less than the R_1 value of 0.57 presented in Sect. 5.2.1; and therefore we chose the NRC value for use in the AIRDOS-EPA sample run (Appendix B).

5.3 Deposition Velocity V_d

The deposition velocity V_d (centimeters per second) is used in the code as a transfer factor relating an air concentration to a surface deposition rate (Hoffman, 1977; Miller et al., 1978). Field measurements of V_d are generally based on measured concentrations in vegetation cut at a specific height above the ground surface and fail to measure total deposition on a unit area basis. The fraction of radionuclide deposited on soil, leaf litter, and uncut vegetation is usually not measured. Thus, an estimate of V_d appropriate for the total deposit on a unit area basis is derived from a V_d specific for deposition onto vegetation by the following method:

$$V_d \text{ (total)} = V_d \text{ (specific for vegetation)}/R \quad , \tag{68}$$

where R is the fraction of atmospherically depositing nuclides intercepted by the above-ground edible portion of the vegetation. Values of V_d (total) are appropriate for use in the AIRDOS-EPA code because V_d is used to estimate plume depletion and total ground area deposition.

The following values of V_d appear to be relevant for forage grasses under dry conditions (Heinemann and Vogt, in press):

1. 2 cm/sec for reactive gases (molecular iodine),
2. 0.1 cm/sec for small particulates (<4 μm in diameter), and
3. 0.01 cm/sec for relatively unreactive gases (CH_3I).

Dividing the above specific V_d values by a mean forage grass interception fraction R_1 of 0.57 (Sect. 5.2.1) produces the following values of V_d (total):

1. 3.5 cm/sec for reactive gases,
2. 0.18 cm/sec for small particulates, and
3. 0.018 cm/sec for relatively unreactive gases.

These values are specific for deposition on grasslands. It is assumed in the code that the V_d (total) for grasslands is equal to the V_d (total) for vegetable crops. This assumption may be false since depositional conditions for grasslands and vegetable croplands are probably different (Hosker, 1974); however, measured values of V_d (total) have not been published for vegetable crops. We propose that the value of V_d (total) for particulates >4 μm in diameter be set equal to the gravitational fall velocity of the particle size considered (Sehmel et al., 1973).

There is a potential for error in calculating plume depletion in atmospheric transport models from a specific value of V_d (total) calculated for a grassland environment. When various environmental conditions such as buildings, trees, rough terrain, and other potential scavengers are present, the use of a different V_d (total) may be warranted.

5.4 The Plant/Soil Bioaccumulation Factor B_{iv}

The transfer of radionuclides from soil to the above-ground portions of pasture grasses is parameterized by B_{iv1}. Radionuclide transfer from soil to the edible portions of leafy vegetables and fresh produce ingested by man is parameterized by B_{iv2}. In the model, it is assumed that radionuclides incorporated into nonedible portions of vegetable crops are returned to the soil by the plowing under of the nonedible portion after harvesting of the edible portion.

A review of the available literature was made to determine values of B_{iv1} and B_{iv2} for various elements. Measurements of radionuclide concentrations in soil and vegetation reported in the literature are given in both fresh and dry weight for vegetation and may be specific for both edible and nonedible plant portions. Thus, only data which was applicable to (or could easily be converted to conform with) the following definitions of B_{iv1} and B_{iv2} were considered. The definitions of B_{iv1} and B_{iv2} are as follows:

$$B_{iv1} = \frac{\text{radionuclide concentration in entire above-ground portion of plant at maturity per unit dry wt}}{\text{radionuclide concentration in soil per unit dry wt}}$$

$$B_{iv2} = \frac{\text{radionuclide concentration in edible portion of plant at maturity per unit fresh wt}}{\text{radionuclide concentration in soil per unit dry wt}}$$

The effects of chemical and physical forms of the element will likely influence B_{iv} values to a greater extent than isotopic effects. Therefore, element-specific, rather than isotope-specific values of B_{iv} were chosen. This consideration allows consolidation of measured B_{iv} values and incorporation of a greater number of references into the determination of B_{iv}.

Determinations of B_{iv1} and B_{iv2} (Tables 9 and 10, respectively) were made from original literature references whenever available. However, the review document by Ng et al. (1968) was used to derive B_{iv} values when original sources were unavailable. References in which

Table 9. Values of B_{ivl} derived from a review of the literature

Element	B_{ivl}	References
Sr	1.2×10^{0}	Hardy et al., (1969) Arkhipov et al. (1974) Romney et al. (1957) Romney et al. (1966).
Tc	2.2×10^{2}	Wildung et al. (1977).
I	2.0×10^{-1}	Ng et al. (1978).
Cs	1.5×10^{-1}	Rediske et al. (1955); Haak and Eriksson (1973); Frederiksson et al. (1966); Frederiksson et al. (1969); Evans and Dekker (1968); Hardy et al. (1977); Romney et al. (1957); Barber (1964).
Pb	1.1×10^{-1}	Cox and Rains (1972); Zimdahl et al. (1978); Rabinowitz (1972); Dedolph et al. (1970).
Po	4.2×10^{-3}	Watters et al. (1969).
Ra	9.7×10^{-2}	Kirchmann et al. (1968); Taskayev et al. (1977); Debortoli and Gaglione (1972).
Ac	1.0×10^{-2}	Ng et al. (1968) (based on 25% dry matter).
Th	2.7×10^{-3}	Bondietti et al. (in press).
Pa	1.0×10^{-2}	Ng et al. (1968) (based on 25% dry matter).
U	8.5×10^{-3}	Bondietti et al. (in press). Adams et al. (1955).
Pu	2.2×10^{-3}	Romney et al. (1970); Price (1972); Rediske et al. (1955); Cummings and Bankert (1971); Adams et al. (1975); Hardy et al. (1977); Brown and McFarlane (1978); Bondietti et al. (in press).

Table 10. Values of B_{iv2} derived from a review of the literature

Element	B_{iv2}	References
Sr	2.9×10^{-1}	Romney et al. (1957); Essington et al. (1962); Arkhipov et al. (1974); Hardy et al. (1977).
Tc[a]	1.1×10^{0}	Wildung et al. (1977).
I	5.5×10^{-2}	Ng et al. (1978).
Cs	9.3×10^{-3}	Romney et al. (1957); Schulz (1965); Haak and Eriksson (1973) Fredriksson et al. (1966); Fredriksson et al. (1969); Evans and Dekker (1968); Hardy et al. (1977); Essington et al. (1962).
Pb	3.9×10^{-3}	Wilson and Cline (1966); Ter Haar (1979); John and Van Laerhoven (1972); Rabinowitz (1972); Dedolph et al (1970).
Po	2.6×10^{-4}	Watters et al. (1969).
Ra	6.2×10^{-2}	Vavilov et al. (1964); Mordberg et al. (1976); Kirchmann et al. (1968); DeBortoli and Gaglione (1972).
Ac	2.5×10^{-3}	Ng et al. (1968).
Th	3.5×10^{-4}	Bondietti et al. (in preparation).
Pa	2.5×10^{-3}	Ng et al. (1968).
U	2.9×10^{-4}	Bondietti et al. (in press); Adams et al. (1975).
Pu	2.0×10^{-4}	Cline (1968); Wilson and Cline, (1966); Cummings and Bankert (1971); Dahlman et al (1976); Bondietti and Sweeton (1976); Schulz et al. (1975); Adams et al. (1975); Hardy et al. (1977); Brown and McFarlane (1978).

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[a] The derived value for technetium was 5.5×10^{1}. This value has been adjusted to account for removal of vegetable crops by harvesting over 100 years (see Sect. 5.4.1).

directly deposited or resuspended material may have significantly contributed to the reported plant radionuclide concentration were not considered in our analysis of B_{iv}.

The derived value of B_{iv2} for technetium is relatively high with respect to B_{iv2} values for the other elements (Table 10). The harvesting and removal of vegetable crops from the soil may remove significant quantities of technetium from the agricultural system over long periods of time. This removal after 100 years may be quite significant. The following procedure to adjust the technetium B_{iv2} is made to simulate the effect of harvesting and removal of vegetable crops on the soil concentration of technetium. Without an adjustment of the B_{iv2} value for technetium given in Table 10, the AIRDOS-EPA model would overpredict technetium concentrations in vegetables after 100 years with an average of one harvest per year, because the model assumes no radionuclide loss from the soil via uptake by crop plants and their subsequent harvesting. An estimate of this removal effect k is given by the following equation:

$$k = \frac{C_{sh}}{C_{sn}} \quad , \tag{69}$$

where

k = adjustment factor to account for removal of technetium from soil via harvesting of crops,

C_{sh} = concentration of technetium in soil after 100 years with harvesting of vegetable crops,

C_{sn} = concentration of technetium in soil after 100 years with no harvesting of vegetable crops.

The concentration of technetium in soil with a deposition rate of 1 Ci/m^2-year would be C_{sn} = 100 Ci/m^2 after 100 years with no removal via harvesting or other removal processes. The concentration of technetium in soil with removal by harvesting of the crop after 100 years is given by:

$$C_{sh} = \sum_{n=1}^{100} d_s f^{n-1} = d_s \frac{1 - f^{100}}{1 - f} , \tag{70}$$

where

f = the fraction of technetium remaining in the soil after one year,

n = time in years = 100 years,

d_s = deposition rate on soil (Ci/m^2-year).

The fraction of technetium remaining in the soil after one year is given by:

$$f = \frac{1 - (B_{iv2} \cdot Y_{v2})}{P} , \tag{71}$$

where

B_{iv2} = the plant/soil bioaccumulation factor,

Y_{v2} = the standing crop biomass of the edible portion of the vegetable crop in kg/m^2,

P = the effective surface density of the soil in kg/m^2.

Using values of $n = 100$ year, $d_s = 1$ Ci/m^2 year, $B_{iv2} = 5.5 \times 10^1$, $Y_{v2} = 2.0$ kg/m^2, and $P = 215$ kg/m^2 and substituting Eq. (71) into Eq. (70), a value of $C_{sh} = 2.0 \times 10^0$ results. Thus, the value of k in Eq. (69) is 2.0×10^{-2}. Multiplying k by the above value of B_{iv2} for technetium gives an effective B_{iv2} of 1.1×10^0. This adjusted value of B_{iv2} is given in Table 10. For our determination of B_{iv1}, it is assumed that technetium removed from the soil by forage plants is returned to the soil via excretion by grazing animals and decay of ungrazed grasses. Thus, the above calculation was not performed for B_{iv1}.

5.5 Milk-Transfer Coefficient F_m

The milk-transfer coefficient F_m represents the fraction of the total daily intake of a nuclide which is transferred to a liter of the cow's milk at equilibrium. Unfortunately, very few measurements of F_m involve equilibrium conditions. Usually, single oral doses are administered to the cow, and milk concentrations are monitored for several days. Values of F_m can be derived from such experiments according to the methodology described by Ng et al. (1977) in which the total fraction of the oral dose recovered in milk after six days or more is divided by the daily rate of milk production.

Determinations of F_m (Table 11) were made from original literature references whenever available. However, for many elements the well-documented review by Ng et al. (1977) was the primary literature source. References in which the chemical form of the nuclide administered orally to the cow was clearly atypical of forms found in the environment were excluded from the analysis of F_m. As for the analysis of B_{iv}, the values of F_m given in Table 11 are element- rather than nuclide-specific.

5.6 The Meat-Transfer Coefficient F_f

The meat-transfer coefficient F_f represents the fraction of the total daily intake of a nuclide which is transferred to a kilogram of muscle in the meat-producing animal at equilibrium. (For the demonstration

Table 11. Estimates of the milk-transfer coefficient F_m for dairy cows

Element	F_m (day/liter)	References
Sr	2.4×10^{-3}	Cragle and Dermott (1959); Garner et al (1960); Squire et al. (1958); Comar et al. (1961).
Tc	9.9×10^{-3}	Ng et al. (1977).
I	1.0×10^{-2}	Ng et al. (1977); Hoffman (1979).
Cs	5.6×10^{-3}	Hawthorne (1967); Ward et al. (1965); Johnson et al. (1968).
Pb	9.9×10^{-5}	Stanley et al. (1971); Kerin and Kerin (1971); Nelmes et al. (1974); Donovan et al. (1969); Bovay (1971); Lynch et al. (1974).
Po	1.2×10^{-4}	McInroy (1973).
Ra	5.9×10^{-4}	Kirchmann et al. (1972).
Ac	2.0×10^{-5}	Ng et al. (1977).
Th	5.0×10^{-6}	Ng et al. (1977).
Pa	5.0×10^{-6}	Ng et al. (1977).
U	1.2×10^{-4}	Chapman and Hammons (1963).
Pu	4.5×10^{-8}	Sansom (1964); Garten (1978)[a]

[a] Derived from range based on a review of Stanley et al. (1976) and reported by Garten (1978).

run, beef is the meat consumed at the specified environmental locations.) It is assumed that equilibrium conditions exist when slaughter occurs. Measured intake rates and associated meat and forage elemental concentrations may yield values of F_f which are suspect, because it has not been conclusively shown that equilibrium between intake rate and meat concentration are ever attained. Thus, the age and time of exposure from intake for each animal may significantly influence the measured value. However, a review of the available literature was made to give estimates of F_f for beef cattle (Table 12).

Values of F_f based on immature cattle (less than 6 months of age) were excluded from analysis when data for adult cattle were available. Data for other ruminant species were included when literature references for cattle F_f's were unavailable. Extrapolation from these species to beef cattle may result in invalid conclusions.

5.7 Other Environmental Terrestrial Transport Parameters

A list of environmental parameters used in the AIRDOS-EPA code demonstration run, and not previously discussed above, are given in Tables 13 and 14. Values of the radiological decay constant λ_i (day^{-1}) are taken from Kocher (1977). The values for the parameters f_p, f_s, Q_F, and P (defined in Table 6) are the means of their respective statistical distributions as described in Hoffman and Baes (1979). Other parameter values are taken from the U.S. NRC Regulatory Guide 1.109 (1977).

Table 12. Estimates of the meat-transfer coefficient F_f for beef cattle

Element	F_f (day/kg)	References
Sr	3.0×10^{-4}	Ng et al. (1978).
Tc	8.7×10^{-3}	Ng et al. (1968).
I	7.0×10^{-3}	Ng et al.,(1978).
Cs	1.4×10^{-2}	Ward and Johnson (1965).
Pb	9.1×10^{-4}	Nelmes et al. (1974).
Po	4.0×10^{-3}[a]	Beasley and Palmer (1966); Holtzman (1966,a) Hill (1965).
Ra	5.0×10^{-4}[b]	Hardy et al. (1969); Bell (1978); Holtzman (1955a,b).
Ac	1.6×10^{-6}[c]	
Th	1.6×10^{-6}[c]	
Pa	1.6×10^{-6}[c]	
U	1.6×10^{-6}[c]	
Pu	4.1×10^{-7}	Ng et al. (1978); Garten (1978)[d]

[a] F_f values are specific for caribou and reindeer using daily food intake rates estimated by Liden and Gustafsson (1966).

[b] F_f values are specific for sheep, caribou, and reindeer using daily food intake rates estimated by Liden and Gustafsson (1966) for caribou and reindeer and by Bell (1978) for sheep.

[c] F_f value estimated by using value for americium and curium given by Ng et al. (1978).

[d] Derived from range based on a review of Stanley et al. (1978) and reported by Garten (1978).

Table 13. Radiological decay constant λ_i for selected nuclides[a]

Nuclide	λ_i (day^{-1})
^{3}H	1.54×10^{-4}
^{14}C	3.32×10^{-7}
^{89}Sr	4.32×10^{-2}
^{90}Sr	6.54×10^{-5}
^{99}Tc	8.92×10^{-9}
^{131}I	8.62×10^{-2}
^{210}Pb	8.52×10^{-5}
^{210}Po	5.02×10^{-3}
^{222}Rn	1.81×10^{-1}
^{226}Ra	1.19×10^{-6}
^{228}Ra	3.15×10^{-4}
^{227}Ac	8.72×10^{-5}
^{228}Th	9.93×10^{-4}
^{230}Th	2.47×10^{-8}
^{232}Th	1.35×10^{-13}
^{231}Pa	5.82×10^{-8}
^{234}U	7.77×10^{-9}
^{235}U	2.68×10^{-12}
^{238}U	4.25×10^{-13}
^{238}Pu	2.17×10^{-5}
^{239}Pu	7.79×10^{-8}

[a] Derived from Kocher (1977).

Table 14. Environmental parameters used in AIRDOS-EPA to estimate radionuclide concentrations in meat, milk, and vegetables consumed by man[a]

Parameter	Value	Units	Reference
t_{e1}	720	hr	U.S. NRC Reg. Guide 1.109 (1977)
t_{e2}	1440	hr	U.S. NRC Reg. Guide 1.109 (1977)
f_p	0.4		Shor and Fields (1979b)
f_s	0.4		Shor and Fields (1979b)
Q_F	16	kg/day	Shor and Fields (1979a)
t_f	4	days	U.S. NRC Reg. Guide 1.109 (1977)
t_s	20	days	U.S. NRC Reg. Guide 1.109 (1977)
t_b	8.76×10^5	hr	
t_{h1}	0	hr	U.S. NRC Reg. Guide 1.109 (1977)
t_{h2}	2160	hr	U.S. NRC Reg. Guide 1.109 (1977)
t_{h3}	336	hr	U.S. NRC Reg. Guide 1.109 (1977)
t_{h4}	336	hr	U.S. NRC Reg. Guide 1.109 (1977)
λ_w	0.0021	hr^{-1}	U.S. NRC Reg. Guide 1.109 (1977)
P	215	kg/m^2 (dry wt)	Derived from Baes (1979)
RD_1[b]	0.63		
RD_2[b]	0.20		
RW_1[b]	0.63		
RW_2[b]	0.20		

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[a] For a description of the parameter see Table 6.

[b] We have not been able to determine values of R_1 and R_2 specific for dry and wet deposition.

5.8 Ingestion and Inhalation Rates U_{ap} for the Average Adult

The available surveys on food ingestion and air inhalation rates have recently been reviewed by Rupp (1979). The values in Table 15 are the mean values of the ranges found by Rupp and are specific for the average adult. These values are used in the demonstration run of the code to estimate population doses.

Table 15. Ingestion and inhalation rates U_{ap} for the average adult[a]

Pathway	Rate
Leafy vegetables U_{ap}^{L}	18 kg/year
Other fresh produce U_{ap}^{V}	176 kg/year
Meat (excluding fish) U_{ap}^{F}	94 kg/year
Milk U_{ap}^{M}	112 liter/year
Inhalation U_{ap}^{I}	8030 m^3/year

[a] Values listed are given by Rupp (1979).

6. REFERENCES

Adams, W. H., J. R. Buckholz, C. W. Christenson, G. L. Johnson, and E. B. Fowler. 1975. *Studies of Plutonium, Americium, and Uranium in Environmental Matrices*. LA-5661, Los Alamos Scientific Laboratory, Los Alamos, New Mexico.

Arkhipov, N. P., Y. A. Fedorov, E. F. Bondar, R. M. Aleksakhin, G. N. Romanov, and L. T. Feuraleva. 1974. Predicting ^{90}Sr accumulation in the crop harvest as a result of its uptake from the soil. *Soviet Soil Sci.* 6(4): 412-419.

Baes, C. F., III. 1979. The soil loss constant λ_{s1}, due to leaching from soils. IN Hoffman, F. O. and C. F. Baes, III (eds.). *A Statistical Analysis of Selected Parameters for Predicting Food Chain Transport and Internal Dose of Radionuclides. Final Report.* ORNL/NUREG/TM-282.

Baes, C. F., III and T. H. Orton. 1979. Productivity of agricultural crops and forage Y_v. IN Hoffman, F. O. and C. F. Baes, III (eds.). *A Statistical Analysis of Selected Parameters for Predicting Food Chain Transport and Internal Dose of Radionuclides. Final Report.* ORNL/NUREG/TM-282.

Barber, D. A. 1964. Influence of soil organic matter on the entry of cesium-137 into plants. *Nature* 294: 1326-1327.

Beasley, T. M. and H. E. Palmer. 1966. Lead-210 and polonium-210 in biological samples from Alaska. *Science* 152: 1062-1064.

Bell, C. Professor, Animal Science Department, University of Tennessee, Knoxville, Tenn. 37916. 1978. Personal communication to A. P. Watson, August 17, 1978.

Bondietti, E. A. and F. H. Sweeton. 1976. Transuranic speciation in the environment. pp. 449-476. IN *Transuranics in Natural Environments*. NVO-178.

Bondietti, E. A., J. R. Trabalka, C. T. Garten, and G. G. Killough. In press. Biochemistry of actinides: A nuclear fuel cycle perspective. IN *Radioactive Waste in Geologic Storage*. American Chemical Society Symposium Service.

Bondietti, E. A., C. T. Garten, Jr., C. W. Francis, and Eyman, L. D. (in preparation). Uranium and thorium in the biosphere: A review emphasizing behavior applicable to the thorium fuel cycle. *Journal of Environmental Quality*.

Booth, R. S., S. V. Kaye, and P. S. Rohwer. 1971. Systems analysis methodology for predicting dose to man from a radioactively contaminated terrestrial environment. pp. 877-893. IN *Radionuclides in Ecosystems, Proceedings of the Third National Symposium on Radioecology*. CONF-710501.

Bovay, E. 1971. Accumulation of Pb on vegetation along expressways. Feeding tests on dairy cows with forage contaminated with Pb. pp. 101-117. IN Switzerland Federal Committee for Air Hygiene Investigations: The Problem of Leaded Gasoline. *Bull. der Eidg. Gesundheitsamtes* Suppl. B, No. 3.

Briggs, G. A. 1969. *Plume Rise, AEC Critical Review Series*. TID-25075.

Brown, K. W. and J. C. McFarlane. 1978. Plutonium uptake by plants grown in soil containing plutonium-238 dioxide particles. *Health Phys.* 35:481-485.

Chamberlain, A. C. 1970. Interception and retention of radioactive aerosols by vegetation. *Atm. Environ.* 4:57-78.

Chapman, T. S. and S. Hammons, Jr. 1963. Some observations concerning uranium content of ingesta and excreta of cattle. *Health Phys.* 9: 79-81.

Cline, J. F. 1968. Uptake of ^{241}Am and ^{239}Pu by plants. pp. 8.24-8.25. IN Thompson, R. C. and Paulette Teal (eds.). *Pacific Northwest Laboratory Annual Report for 1967 to the USAEC Division of Biology and Medicine, Volume I.* BNWL-714.

Comar, C. L., R. H. Wasserman, and A. R. Twardock. 1961. Secretion of calcium and strontium into milk. *Health Phys.* 7: 69-80.

Cox, W. J. and D. W. Rains. 1972. Effect of lime on Pb uptake by five plant species. *J. Environ. Qual.* 1(2): 167-71.

Cragle, R. G. and B. J. Demott. 1959. Strontium and calcium uptake and excretio in lactating dairy cows. *J. Dairy Sci.* 42(8): 1367-1372.

Culkowski, W. M. and M. R. Patterson. 1976. *A Comprehensive Atmospheric Transport and Diffusion Model.* ORNL/NSF/EATC-17.

Cummings, S. L. and L. Bankert. 1971. The uptake of cerium-144, promethium-147, and plutonium-238 by oat plants from soils. *Radiat. Data Rep.* 12(2): 83-85.

Dahlman, R. C., E. A. Bondietti, and L. D. Eyman. 1976. Biological pathways and chemical behavior of plutonium and other actinides in the environment. pp. 47-80 IN A. M. Friedman (ed.). *Actinides in the Environment, ACS Symposium Series 35.* American Chemical Society, Washington.

DeBortoli, M. and P. Gaglione. 1972. Radium-226 in environmental materials and foods. *Health Phys.* 22(1): 43-48.

Dedolph, R., G. Ter Haar, R. Holtzman, and H. Lucas, Jr. 1970. Sources of Pb in perenniel ryegrass and radishes. *Environ. Sci. Technol.* 4(3): 217-225.

Donovan, P. P., D. T. Feeley, and P. P. Canavan. 1969. Lead contamination in mining areas in Western Ireland II. Survey of animals, pastures, foods, and waters. *J. Sci. Fd. Agric.* 20: 43-45.

Essington, E., H. Nishita, and A. Wallace. 1962. Influence of chelates on availability of fission products to plants grown in a contaminated soil. *Soil Sci.* 94: 96-105.

Evans, E. J. and A. J. Dekker. 1968. Comparative Cs-137 content of agricultural crops grown in a contaminated soil. *Can. J. Plant Sci.* 48: 183-188.

Evans, R. D. 1969. Engineer's guide to the elementary behavior of radon daughters. *Health Phys.* 17: 229-252.

Fredriksson, L. Å. Eriksson, and H. Lönsjö. 1966. *Studies on Plant Accumulation of Fission Products under Swedish Conditions. VIII. Uptake of* ^{137}*Cs in Agricultural Crops as Influenced by Soil Characteristics, and Rate of Potassium Fertilization in a Three Year Micro Plot Experiment.* Research Institute of National Defense. Stockholm, Sweden, FOA 4 Rapport A 4486-4623.

Fredriksson, L., H. Lönsjö, and Å. Eriksson. 1969. *Studies on Plant Accumulation of Fission Products under Swedish Conditions. XII. Uptake of* ^{137}*Cs by Barley and Peas from 12 Different Top Soils Combined with 2 Subsoils in a Long Term Micro Plot Experiment.* Research Institute of National Defense. Stockholm, Sweden, FOA 4 Rapport C 4405-4428.

Garner, R. J., H. G. Jones, and B. F. Sansom. 1960. Fission products and the dairy cow: 2. Some aspects of the metabolism of the alkaline earth elements calcium, strontium, and barium. *Biochem. J.* 76: 572.

Garten, C. T. 1978. A review of parameter values used to assess the transport of plutonium, uranium, and thorium in terrestrial food chains. *Environmental Research* (in press).

Gifford, F. A., Jr. 1961. Use of routine meteorological observations for estimating atmospheric dispersion. *Nucl. Saf.* 2(4): 47-57.

Gifford, F. A., Jr. 1976. Turbulent diffusion-typing schemes: A review. *Nucl. Saf.* 17(1): 68-86.

Haak, E. and Å. Eriksson. 1973. *Studies on Plant Accumulation of Fission Products under Swedish Conditions. VIX. Uptake of* ^{137}*Cs by Wheat and Timothy from Six Different Soils as Influenced by Rate of K-Fertilization and by Type and Rate of N-Fertilization in Pot Experiments.* The Research Institute of National Defence, Stockholm, Sweden, FOA 4 Rapport C 4557-A3.

Hardy, E., J. Rivera, I. Fisenne, W. Pond, and D. Hogue. 1969. Comparative utilization of dietary radium-226 and other alkaline earths by pigs and sheep. pp. 183-190. IN Sikov, M. R. and D. D. Mahlum (eds.). *Proceedings of the Ninth Annual Hanford Biology Sumposium, Richland, Washington, May 5-8, 1969.* CONF-690501.

Hardy, E. P., B. G. Bennett, and L. T. Alexander. 1977. *Radionuclide Uptake by Cultivated Crops.* HASL-321, Health and Safety Laboratory, New York.

Hawthorne, H. A. 1967. Field studies of the transfers of ^{137}Cs from fallout to milk. pp. 77-85. IN B. Aberg and F. P. Hungate (eds.). *Radiological Concentration Processes, Proceedings of an International Symposium in Stockholm, Sweden, April 1966.*

Heinemann, K. and Vogt, K. J. In press. Messungen zur ablagerung und biologischen halbwertszeit von jod auf vegetation. *Proceedings of the 12th Annual Symposium of the Fachverband fur Strahlenschutz, October 2-6, 1978, Norderney, Federal Republic of Germany.*

Hill, C. R. 1965. Polonium-210 in man. *Nature* 208(5009): 423-428.

Hoffman, F. O. 1977. A reassessment of the deposition velocity in the prediction of the environmental transport of radioiodine from air to milk. *Health Phys.* 32(5): 437-441.

Hoffman, F. O. 1979. The coefficient for the transfer of radionuclides from animal intake to milk F_m. IN Hoffman, F. O. and C. F. Baes, III (eds.). *A Statistical Analysis of Selected Parameters for Predicting Food Chain Transport and Internal Dose of Radionuclides. Final Report.* ORNL/NUREG/TM-282.

Hoffman, F. O. and C. F. Baes, III (eds.). 1979. *A Statistical Analysis of Selected Parameters for Predicting Food Chain Transport and Internal Dose of Radionuclides. Final Report.* ORNL/NUREG/TM-282.

Holtzman, R. B. 1966a. Natural levels of lead-210, polonium-210 and radium-226 in humans and biota of the arctic. *Nature* 210: 1094-1097.

Holtzman, R. B. 1966b. ^{226}Ra and the natural airborne nuclides ^{210}Pb and ^{210}Po in arctic biota. pp. 1087-1096. IN Snyder, W. S. (ed.). *Proceedings of the First International Congress of Radiation Protection.* IRPA. Rome, 5-10 September 1966.

Holzworth, G. C. 1972. *Mixing Heights, Wind Speeds and Potential for Urban Air Pollution throughout the Contiguous United States.* Publication No. AP-101. U.S. Environmental Protection Agency, Office of Air Programs, Research Triangle Park, N.C. 27711.

Horst, T. W. 1977. A surface depletion model for deposition from a Gaussian plume. *Atmos. Environ.* 11: 41-46.

Hosker, R. P., Jr. 1974. Estimates of dry deposition and plume depletion over forests and grassland. pp. 29-309. IN *Physical Behavior of Radioactive Contaminants in the Atmosphere*. Proc. of a Symposium jointly organized by the IAEA and the World Meteorological Organization. Vienna, 12-16 November 1973.

John, M. K. and C. J. Van Laerhoven. 1972. Lead distribution in plants grown on a contaminated soil. *Environ. Lett.* 3(2): 111-116.

Johnson, J. E., G. M. Ward, E. Firestone, and K. L. Knox. 1968. Metabolism of radioactive cesium (^{134}Cs and ^{137}Cs) and potassium by dairy cattle as influenced by high and low forage diets. *J. Nutr.* 94: 282-288.

Kerin, D. and Z. Kerin. 1971. Lead contamination of milk and honey caused by industrial lead aerosols. *Prot. Vitae* 2: 61-62. IN *Kettering Abstracts* 9(240): 206-207.

Killough, G. G. and L. R. McKay. 1976. *A Methodology for Calculating Radiation Doses from Radioactivity Released to the Environment*. ORNL-4992.

Killough, G. G. and P. S. Rohwer. 1978. A new look at the dosimetry of ^{14}C released to the atmosphere as carbon dioxide. *Health Phys.* 34: 141-159.

Killough, G. G., D. E. Dunning, Jr., S. R. Bernard, and J. C. Pleasant. 1978. *Estimates of Internal Dose Equivalent to 22 Target Organs for Radionuclides Occurring in Routine Releases from Nuclear Fuel-Cycle Facilities. Vol. 1.* ORNL/NUREG/TM-190.

Kirchmann, R., A. Lafontaine, J. van der Hoek, and G. Koch. 1972. Comparison of the rate of transfer to cow milk of ^{226}Ra from drinking water and ^{226}Ra incorporated in hay. *C. R. Soc. Biol.* 166(11): 1557-1562.

Kirchmann, R., R. Boulenger, and A. LaFontaine. 1968. Absorption of ^{226}Ra in cultivated plants. pp. 1045-1051. IN W. S. Snyder *et al.* (eds.). *Proceedings of the IRPA Congress on Radiation Protection*. Rome, 1966, Vol. II, Pergamon Press.

Kocher, D. C. (ed.). 1977. *Nuclear Decay Data for Radionuclides Occurring in Routine Releases from Nuclear Fuel Cycle Facilities*. ORNL/NUREG/TM-102.

Kocher, D. C. 1979. *Dose-Rate Conversion Factors for External Exposure to Photon and Electron Radiation from Radionuclides Occurring in Routine Releases from Nuclear Fuel Cycle Facilities*. ORNL/NUREG/TM-283.

Lidén, K., and M. Gustafsson. 1967. Relationships and seasonal variation of ^{137}Cs in lichen, reindeer and man in Northern Sweden 1961 to 1965. p. 193. IN *Proceedings of International Symposium, Stockholm, 1966*. Pergamon Press, Oxford, 1967.

Lynch, G. P., D. G. Cornell, and D. F. Smith. 1974. Excretion of cadmium and lead into milk. pp. 470-474. IN Hoekstra, W. G., J. W. Suttie, H. E. Ganther, and W. Mertz (eds.). *Trace Element Metabolism in Animals - 2*. University Park Press, Baltimore, Md.

McInroy, J. F. 1973. *Polonium-210 Metabolism in Ruminants*. Ph.D. Dissertation. Colorado State University. Fort Collins, Colo.

Markee, E. H., Jr. 1967. A parametric study of gaseous plume depletion by ground surface adsorption. pp. 602-614. IN Mawson, C. A. (ed.). *USAEC Meteorological Information Meeting, September 11-14, 1967*. AECL-2787.

Mills, M. T. and M. Reeves. 1973. *A Multi-Source Atmospheric Transport Model for Deposition of Trace Contaminant*. ORNL/NSF/EATC/2.

Miller, C. W. 1979a. The interception Fraction. IN Hoffman, F. O. and C. F. Baes, III (eds.). *A Statistical Analysis of Selected Parameters for Predicting Food Chain Transport and Internal Dose of Radionuclides. Final Report*. ORNL/NUREG/TM-282.

Miller, C. W. 1979b. Validation of a model to predict aerosol interception by vegetation. IN *International Symposium on Biological Implications of Radionuclides Released from Nuclear Industries*. IAEA-SM-237/53. Vienna, 26-30 March 1979.

Miller, C. W., F. O. Hoffman, and D. L. Shaeffer. 1978. The importance of variations in the deposition velocity assumed for the assessment of airborne radionuclide releases. *Health Phys*. 34: 730-734.

Moore, R. E. 1978. *AREAS: A Computer Code for Estimating Air Pollutant Concentrations from Dispersed Sources*. ORNL/TM-6364.

Moore, R. E. 1977. *The AIRDOS-II Computer Code for Estimating Radiation Dose to Man from Airborne Radionuclides in Areas Surrounding Nuclear Facilities*. ORNL-5245.

Mordberg, E. L., V. M. Aliksandruk, G. F. Kovygin, I. I. Shevckenko, V. M. Blyumshtein, and G. F. Yushkevich. 1976. Translocation of isotopes of the uranium-radium series into the grain of some agricultural crops. *Gig. Sanit*. 2: 58-61 (Abstract only, *Chem. Abstr*. 84: 134563).

Morrison, Frank B. 1956. *Feeds and Feeding. A Handbook for the Student and Stockman*. 22nd ed. The Morrison Publishing Co., Ithaca, New York.

Nelmes, A. J., R. St. J. Buxton, F. A. Fairweather, and A. E. Martin. 1974. The implication of the transfer of trace metals from sewage sludge to man. pp. 145-153 IN *Proceedings of the University of Missouri 8th Annual Conference on Trace Substances in Environmental Health.*

Ng, Y. C., C. A. Burton, S. E. Thompson, R. K. Tandy, H. K. Kretner, and M. W. Pratt. 1968. Prediction of the maximum dosage to man from the fallout of nuclear devices. IN *Handbook for Estimating the Maximum Internal Dose from Radionuclides Released to the Biosphere.* UCRL-50163, pt. IV. Lawrence Radiation Laboratory.

Ng, Y. C., C. S. Colsher, D. J. Quinn, and S. E. Thompson. 1977. *Transfer Coefficients for the Prediction of the Dose to Man via the Forage-Cow-Milk Pathway from Radionuclides Released to the Biosphere.* UCRL-51939, Lawrence Livermore Laboratory.

Ng, Y. C., W. A. Phillips, Y. E. Ricker, R. K. Tandy, and S. E. Thompson. 1978. *Methodology for Assessing Dose Commitment to Individuals and to the Population from Ingestion of Terrestrial Foods Contaminated by Emissions from a Nuclear Fuel Reprocessing Plant at the Savannah River Plant - Draft Report.* UCID-17743.

Pasquill, F. 1961. The estimation of the dispersion of windborne material. *Meteorol. Mag.* 90: 33.

Pleasant, J. C. 1979. *INGDOS - A Conventional Computer Code to Implement U.S. Nuclear Regulatory Guide 1.109 Models for Estimation of Annual Doses from Ingestion of Atmospherically Released Radionuclides in Food.* ORNL/TM-6100.

Price, K. R. 1972. *Uptake of ^{237}Np, ^{239}Pu, ^{241}Am, and ^{244}Cm from Soil by Tumbleweed and Cheatgrass.* AEC Research and Development Report. BNWL-1688.

Rabinowitz, M. 1972. Plant uptake of soil and atmospheric lead in Southern California. *Chemosphere* 1(4): 175-180.

Rediske, J. H., J. F. Cline, and A. A. Selders. 1955. *The Absorption of Fission Products by Plants.* HW-36734.

Romney, E. M., A. J. Steen, R. A. Wood, and W. A. Rhoads. 1966. Concentration of radionuclides by plants grown on ejecta from the sedan thermonuclear cratering detonation. pp. 391-398. IN *Radioecological Concentration Processes.* Proceedings of International Symposium, Stockholm, Sweden.

Romney, E. M., H. M. Mork, and K. H. Larson. 1970. Persistence of plutonium in soil, plants, and small mammals. *Health Phys.* 19: 487-491.

Romney, E. M., J. W. Neel, H. Nishita, J. H. Olafson, and K. H. Larson. 1957. Plant uptake of ^{90}Sr, ^{91}Y, ^{106}Ru, ^{137}Cs, and ^{144}Ce from soils. *Soil Sci.* 83: 369-376.

Rupp, A. F., S. E. Beall, L. P. Bornwasser, and D. H. Johnson. 1948. *Dilution of Stock Gasses in Cross Winds.* USAEC Report AECD-1811 (CE-1620). Clinton Laboratories.

Rupp, E. M. 1979. Dietary intake and inhalation rates U_{ap}. IN Hoffman, F. O. and C. F. Baes, III (eds.). *A Statistical Analysis of Selected Parameters for Predicting Food Chain Transport and Internal Dose of Radionuclides. Final Report.* ORNL/NUREG/TM-282.

Sansom, B. F. 1964. The transfer of plutonium-239 from the diet of a cow to its milk. *Br. Vet. J.* 120: 158-161.

Schulz, R. K. 1965. Soil chemistry of radionuclides. *Health Phys.* 11: 1317-1324.

Schulz, P. K., G. A. Tompkins, and K. J. Babock. 1975. Uptake of plutonium and americium by plants from soil: uptake by wheat from various soils and effect of oxidation of plutonium added to soil. IN *Proceedings of International Symposium on Transuranium Nuclides in the Environment.* San Francisco, 17-21 November 1975, Vienna, IAEA (1976) as quoted by Bulman, R. A. 1976. *Concentration of Actinides in the Food Chain.* NRPB-R44, Harwell, Didcot, OXon. OX11 ORQ. June 1976.

Sehmel, G. A., S. L. Sutter, and M. T. Dana. 1973. Dry deposition processes. pp. 43-49. IN *Pacific Northwest Laboratory Annual Report for 1972 to the USAEC Division of Biomedical and Environmental Research. Volume II Physical Sciences, Part 1 Atmospheric Sciences.* BNWL-1751 PT1.

Shor, R. W. and D. E. Fields. 1979a. Animal feed consumption rate Q_E. IN Hoffman, F. O. and C. F. Baes, III (eds.). *A Statistical Analysis of Selected Parameters for Predicting Food Chain Transport and Internal Dose of Radionuclides. Final Report.* ORNL/NUREG/TM-282.

Shor, R. W. and D. E. Fields. 1979b. The fraction of total feed composed of fresh forage F_s and the fraction of the year fresh forage is utilized F_p. IN Hoffman, F. O. and C. F. Baes, III (eds.). *A Statistical Analysis of Selected Parameters for Predicting Food Chain Transport and Internal Dose of Radionuclides. Final Report.* ORNL/NUREG/TM-282.

Slade, D. H. (ed.). 1968. *Meteorology and Atomic Energy - 1968.* U.S. Atomic Energy Commission/Division of Technical Information.

Spector, William S. 1956. *Handbook of Biological Data.* W. B. Saunders Co., Philadelphia. p. 187.

Squire, H. M., L. J. Middleton, B. F. Sansom, and C. R. Coid. 1958. Experiments on the metabolism of certain fission products in dairy cows. pp. 207-219. Extermann, R. C. (ed.). IN *Radioisotopes in Scientific Research*, Vol. IV, Pergamon Press.

Stanley, R. E., A. A. Mullen, and E. W. Bretthauer. 1971. Transfer to milk of ingested radiolead. *Health Phys*. 21: 211-215.

Taskayev, A. K., V. Ya. Ovchenkov, R. M. Aleksakhin, and I. I. Shirktomova. 1977. Uptake of ^{226}Ra by plants and change in its state in the soil-plant tops-litterfall system. *Pochvovedeniye* 2: 42-48.

Ter Haar, G. 1979. Air as a source of lead in edible crops. *Environ. Sci. Technol*. 4(3): 226-230.

Turner, D. B. 1969. *Workbook of Atmospheric Dispersion Estimates*. Air Pollution Control Administration. Cincinnati, Ohio.

U.S. Nuclear Regulatory Commission. 1977. Regulatory Guide 1.109, *Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50* Appendix I (Revision 1). Office of Standards Development.

Van der Hoven. I. 1968. Deposition of particles and gasses. pp. 202-208. IN Slade, D. (ed.). *Meteorology and Atomic Energy - 1968*. U.S. Atomic Energy Commission. USAEC TID-24190.

Vavilov, P. P., O. N. Papova, and R. P. Kodaneva. 1964. The behavior of radium in plants. *Dokl. Akad. Nauk.-S.S.S.R.* 517: 992-994 [translated abstract *Nucl. Sci. Abstr*. 19(2): 2016].

Ward, G. M. and J. E. Johnson. 1965. The cesium-137 content of beef from dairy and feed-lot cattle. *Health Phys*. 11: 95-100.

Ward, G. M., J. E. Johnson, and H. F. Stewart. 1965. ^{137}Cs passage from precipitation to milk. pp. 703-710. IN A. W. Klement, Jr. (ed.). *Radioactive Fallout from Nuclear Weapons Tests*. USAEC Symposium Series #5.

Watters, R. L., J. E. Johnson, and W. R. Hansen. 1969. *A Study of Unsupported Polonium-210 for Ion Exchange in Soil and Uptake in Vegetation*. COO-1733-3, Colorado State University, Fort Collins, Colo.

Wildung, R. E., T. R. Garland, and D. A. Cataldo. 1977. Accumulation of technetium by plants. *Health Phys*. 32: 314-317.

Wilson, D. O. and J. F. Cline. 1966. Removal of plutonium-239, tungsten-185, and lead-210 from soils. *Nature* 209: 941-942.

Zimdahl, R. L., D. T. McCreary, and S. M. Gwynn. 1978. Lead uptake by plants - the influence of lead source. *Bull. Environ. Contam. Toxicol*. 19(4): 431-435.

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Appendix A

LISTING OF THE AIRDOS-EPA CODE

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C
C                 AIRDOS-EPA CODE
C
C     R. E. MOORE  HEALTH AND SAFETY RESEARCH DIV.  ORNL
C
C
      COMMON /OCOM/ NAMNUC(36),WORD,NNUCS,ANLAM(36),RR,SQSD, ACON(36,20,
     >  20),GCON(36,20,20),LIPO,NOMM(36,11),NRMM(36,11), ORMODI(36,12,8)
     > , VD(36),VDCOEF(20,20),NOL,NOU,NRL,NRU
      REAL*8 NAMNUC
      INTEGER OPTION(9)
      REAL*8 WORD,OPT
      DATA OPT/'OPTIONS '/
      READ(50,9004)WORD,OPTION
      IF (WORD.NE.OPT) GO TO 20
      WRITE(51,9005)
      WRITE(51,9006)
      WRITE(51,9007)
      IF (OPTION(1).EQ.1)  WRITE(51,9008)
      IF (OPTION(1).EQ.2)  WRITE(51,9017)
      IF (OPTION(2).EQ.1)  WRITE(51,9009)
      IF (OPTION(2).EQ.0)  WRITE(51,9019)
      IF (OPTION(1).NE.2)  GO TO 10
      CALL DIRECT(OPTION(2))
      CALL DOSEN
      STOP
   10 IF (OPTION(3).EQ.0)  WRITE(51,9011)
      IF (OPTION(3).EQ.1)  WRITE(51,9010)
      IF (OPTION(4).EQ.0)  WRITE(51,9012)
      IF (OPTION(4).EQ.1)  WRITE(51,9013)
      IF (OPTION(5).EQ.1.AND.OPTION(2).EQ.1) WRITE(51,9015)
      IF (OPTION(5).EQ.1.AND.OPTION(2).NE.1) WRITE(51,9016)
      IF (OPTION(5).EQ.1.AND.OPTION(2).NE.1) STOP
      IF (OPTION(6).NE.0)  WRITE(51,9018)OPTION(6)
      IF (OPTION(7).EQ.1)  WRITE(51,9000)
      IF (OPTION(8).EQ.1)  WRITE(51,9001)
      IF (OPTION(9).EQ.1)  WRITE(51,9002)
      IF (OPTION(4).EQ.2)  WRITE(51,9014)
      CALL CONCEN(OPTION(2),OPTION(3),OPTION(4),OPTION(5),OPTION(6),
     > OPTION(7),OPTION(8),OPTION(9),&20)
      IF (OPTION(1).EQ.0)  CALL DOSEN
      STOP
   20 WRITE(51,9003)WORD
      STOP 10
 9000 FORMAT(' ',T30,'THE CALCULATIONS ARE MADE FOR A UNIFORM CIRCULAR A
     >REA SOURCE')
 9001 FORMAT(' ',T30,'THE MAIN OUTPUT TABLE IN SUBROUTINE CONCEN IS NOT
     >PRINTED')
 9002 FORMAT(' ',T30,'THE CHI/Q TABLES ARE NOT PRINTED')
 9003 FORMAT('0ERROR IN DATA DECK.  PROGRAM TERMINATED.  WORD=',A8)
 9004 FORMAT(A8,5I1,I2,3I1)
 9005 FORMAT('1',T50,'OUTPUT OF AIRDOS-EPA COMPUTER CODE')
 9006 FORMAT('0')
 9007 FORMAT(' ',T20,'OPTIONS SELECTED--')
 9008 FORMAT('0',T30,'PROGRAM TERMINATED AFTER PRINTING RADIONUCLIDE CON
     >CENTRATIONS')
 9009 FORMAT(' ',T30,'RADIONUCLIDE CONCENTRATIONS ARE LISTED FOR DIRECTI
     >ON AND DISTANCE FROM FACILITY')
 9010 FORMAT(' ',T30,'RADIONUCLIDE CONCENTRATIONS LISTED ARE PLUME CENTE
     >RLINE VALUES')
 9011 FORMAT('0',T30,'RADIONUCLIDE CONCENTRATIONS LISTED ARE SECTOR-AVER
     >AGED VALUES')
 9012 FORMAT(' ',T30,'PLUME RISE IS COMPUTED FOR BUOYANT PLUMES BY BRIGG
     >S EQUATIONS')
 9013 FORMAT(' ',T30,
     > 'PLUME RISE IS COMPUTED FOR MOMENTUM-TYPE EMISSIONS')
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9014 FORMAT(' ',T30,'SPECIFIC PLUME RISE USED FOR EACH AIR STABILITY CL
    >ASS (METERS)-')
9015 FORMAT('0',T30,'DEPOSITION VELOCITY IS VARIED WITH DIRECTION AND D
    >ISTANCE')
9016 FORMAT('0',T30,'ERROR--ILLEGAL USE OF VARIABLE DEPOSITION VELOCITY
    > WITH SQUARE GRID')
9017 FORMAT('0',T30,'DOSES ARE CALCULATED FROM INPUT AIR CONCENTRATIONS
    > AND GROUND DEPOSITION RATES')
9018 FORMAT(' ',T30,'AIR CONCENTRATIONS AND GROUND DEPOSITION RATES ARE
    > PUNCHED ON CARDS FOR THE FIRST ',I2,' RADIONUCLIDES')
9019 FORMAT(' ',T30,'THE ASSESSMENT AREA IS A 20 BY 20 SQUARE GRID')
     END
      SUBROUTINE CONCEN(LORT,LOST,LRISE,LDEP,LPUN,LARE,LTAB,LCHI,*)
C
      COMMON /OCOM/ NAMNUC(36),WORD,NNUCS,ANLAM(36),RR,SQSD, ACON(36,20,
     >  20),GCON(36,20,20),LIPO,NOMM(36,11),NRHM(36,11), ORMODI(36,12,8)
     > , VD(36),VDCOEF(20,20),NCL,NOU,NFL,NRU
      COMMON /PCOM/ REL(6,36),IDIST(20),NUMST
      COMMON /FCOM/ FEQWL,INTPA(20,20)
      REAL*8 NAMNUC,WORD
C
      REAL*8 W1,W2,W3,W4
      DIMENSION AA(7,4,4),DIA(6),FRAW(7,16),PERD(16),AVON(20,20), PH(6),
     >  PR(7),QH(6), SC(36),TAI(36),TG(3),TGD(36), UDAV(7,16), UDCAT(7,
     > 16),VEL(6),VG(36), NOMA(36),NSPTMO(20,20), NSPTM1(20,10),
     > FDSTOR(36,6,7),BOUND(21),LIST(20)
      DIMENSION DIM(6)
      DATA NOMA/36*0/,ALPH/'    '/
      DATA W1/'AREA    '/,W2/'AIR     '/,W3/'STACKS  '/,W4/'NUCLIDES'/
      EQUIVALENCE (NSPTMO(1,11),NSPTM1(1,1))
      DATA NSPTMO/ 07,07,07,07,08,08,08,08,09,09,09,09,10,10,10,10,11,
     > 11,11,11, 07,07,07,07,08,08,08,08,09,09,09,09,10,10,10,10,11,11,
     > 11,11, 07,07,07,07,07,08,08,08,08,09,09,10,10,10,10,11,11,11,11,
     > 11, 07,07,07,07,07,07,08,08,08,09,09,10,10,10,11,11,11,11,11,11,
     > 06,06,07,07,07,07,08,08,08,09,09,10,10,10,11,11,11,11,12,12, 06,
     > 06,06,07,07,07,07,08,08,09,09,10,10,11,11,11,11,12,12,12, 06,06,
     > 06,06,06,07,07,07,08,09,09,10,11,11,11,12,12,12,12,12, 06,06,06,
     > 06,06,06,07,07,08,09,09,10,11,11,12,12,12,12,12,12, 05,05,06,06,
     > 06,06,06,06,07,08,10,11,12,12,12,12,12,12,13,13, 05,05,05,05,05,
     > 05,05,05,06,07,11,12,13,13,13,13,13,13,13,13/
      DATA NSPTM1/ 05,05,05,05,05,05,05,05,04,03,15,14,13,13,13,13,13,
     > 13,13,13, 05,05,04,04,04,04,04,04,03,02,16,15,14,14,14,14,14,14,
     > 13,13, 04,04,04,04,04,04,03,03,02,01,01,16,15,15,14,14,14,14,14,
     > 14, 04,04,04,04,04,03,03,03,02,01,01,16,15,15,15,14,14,14,14,14,
     > 04,04,04,03,03,03,03,02,02,01,01,16,16,15,15,15,15,14,14,14, 04,
     > 04,03,03,03,03,02,02,02,01,01,16,16,16,15,15,15,15,14,14, 03,03,
     > 03,03,03,03,02,02,02,01,01,16,16,16,15,15,15,15,15,15, 03,03,03,
     > 03,03,02,02,02,02,01,01,16,16,16,16,15,15,15,15,15, 03,03,03,03,
     > 02,02,02,02,01,01,01,01,16,16,16,16,15,15,15,15, 03,03,03,03,02,
     > 02,02,02,01,01,01,01,16,16,16,16,15,15,15,15/
C
C-----THIS ARRAY HOLDS THE VALUES FOR CONSTANTS ASSOCIATED WITH EACH
C-----OF THE 7 PASQUILL AIR STABILITY CATAGORIES (A,C,D,F).
C
      DATA AA/.9757,.9986,.9767,.9600,.9615,.9733,.9986, .8660,.8493,
     > .8540,.8670,.8670,.8540,.8360, .8660,.8493,.8540,.8670,.8670,
     > .8540,.8360, .6294,.6303,.6254,.6342,.6260,.6342,.8360, 3.928,
     > 6.205,7.623,10.00,14.13,21.28,31.03, 1.841,2.213,3.266,5.261,
     > 7.357,9.333,10.093, 1.841,2.213,3.266,5.261,7.357,9.333,10.093,
     > .2083,.2946,.3977,.6166,.8042,1.233,10.093, 1.000,1.000,.9540,
     > .8061,.8600,.8823,.8257, 1.000,1.000,.8330,.6715,.6290,.6321,
     > .6547, 1.000,1.000,.8330,.5099,.4054,.3710,.3818, 1.000,1.000,
     > .5524,.5251,.1110,.1106,.1106, 5.020,8.350,10.015,7.48,15.50,
     > 34.70,61.25, 5.020,8.350,4.400,2.950,3.150,6.132,18.80, 5.020,
     > 8.350,4.400,.8100,.5240,.7640,2.115, 5.020,8.350,.3320,.9300,
     > .0349,.0694,.1739/
C
C---END OF DECLARATIONS
```

```
C
      DO 20 NO=1,20
         DO 10 NR=1,20
   10       VDCOEF(NO,NR)=1.
   20    CONTINUE
      READ(50,9008) NOL,NOU,NRL,NRU
      READ(50,9009) PR
      READ(50,9011) WORD
      IF (WORD.NE.W1)  RETURN 1
      READ(50,9009) SQSD
      READ(50,9000) SEQWL
      READ(50,9008) IDIST
      READ(50,9011) WORD
      IF (WORD.NE.W2)  RETURN 1
      READ(50,9008) LIDA1
      READ(50,9009) RR,TA,TG
      READ(50,9010) PERD
      READ(50,9010) ((UDCAT(I,J),J=1,16),I=1,7)
      READ(50,9010) (( UDAV(I,J),J=1,16),I=1,7)
      READ(50,9012) FRAW
      READ(50,9011) WORD
      IF (WORD.NE.W3)  RETURN 1
      READ(50,9008) NUMST
      DO 30 J=1,NUMST
   30    READ(50,9009) PH(J),DIA(J),VEL(J),QH(J),DIM(J)
      READ(50,9011) WORD
      IF (WORD.NE.W4)  RETURN 1
      READ(50,9008) NNUCS
      DO 40 I=1,NNUCS
         READ(50,9011)  NAMNUC(I)
         READ(50,9009) ANLAM(I),SC(I),VD(I),VG(I)
   40    READ(50,9009) (REL(J,I),J=1,NUMST)
      IF (LDEP.NE.1) GO TO 50
      READ(50,9009)  (BOUND(I),I=2,21)
      READ(50,9059)  ((VDCOEF(I,J),J=NRL,NRU),I=NOL,NOU)
      READ(50,9060)  LIST
      BOUND(1)=0.0
   50 LID1=LIDA1
      FEQWL=SEQWL
      LA1=LIDA1
      IF (LIDA1.EQ.10000)  LA1=ALPH
      IF (LRISE.EQ.2)  WRITE(51,9014) PR
      WRITE(51,9013)
      WRITE(51,9015)
      WRITE(51,9013)
      WRITE(51,9013)
      WRITE(51,9016) TA
      WRITE(51,9017)
      WRITE(51,9018) TG(1)
      WRITE(51,9019) TG(2)
      WRITE(51,9020) TG(3)
      WRITE(51,9022) RR
      WRITE(51,9021) LA1
      WRITE(51,9023) NUMST
      WRITE(51,9013)
      WRITE(51,9013)
      WRITE(51,9024)
      WRITE(51,9013)
      WRITE(51,9025)
      WRITE(51,9026)
      WRITE(51,9027) (PH(I),I=1,NUMST)
      WRITE(51,9028) (DIA(I),I=1,NUMST)
      WRITE(51,9029) (VEL(I),I=1,NUMST)
      WRITE(51,9030) (QH(I),I=1,NUMST)
      IF (LARE.EQ.1)  WRITE(51,9066) (DIM(I),I=1,NUMST)
      WRITE(51,9035)
      WRITE(51,9036)
      WRITE(51,9037)
      WRITE(51,9013)
      DO 70 J=1,NUMST
         DO 60 I=1,NNUCS
            WRITE(51,9038) J,NAMNUC(I),REL(J,I)
   60       CONTINUE
   70    CONTINUE
      WRITE(51,9039)
      WRITE(51,9040)
      WRITE(51,9041)
      WRITE(51,9042)
      WRITE(51,9013)
      DO 80 I=1,NNUCS
         WRITE(51,9043) NAMNUC(I),VG(I),VD(I),SC(I),ANLAM(I)
   80    CONTINUE
C
      WRITE(51,9031)
      WRITE(51,9013)
      WRITE(51,9032)
      WRITE(51,9033)
      WRITE(51,9013)
      DO 90 MO=1,16
         WRITE(51,9034) MO,(FRAW(I,MO),I=1,7)
   90    CONTINUE
      WRITE(51,9044)
      WRITE(51,9013)
      WRITE(51,9045)
      WRITE(51,9046)
      WRITE(51,9047)
      WRITE(51,9013)
      DO 100 I=1,16
         WRITE(51,9048) I,PERD(I),UDCAT(1,I),UDCAT(2,I),UDCAT(3,I),
     >    UDCAT(4,I),UDCAT(5,I),UDCAT(6,I),UDCAT(7,I)
  100    CONTINUE
      WRITE(51,9049)
      WRITE(51,9050)
      WRITE(51,9013)
      WRITE(51,9045)
      WRITE(51,9046)
      WRITE(51,9047)
      WRITE(51,9013)
      DO 110 I=1,16
         WRITE(51,9051) I,PERD(I),UDAV(1,I),UDAV(2,I),UDAV(3,I),UDAV(4,I)
     >      , UDAV(5,I),UDAV(6,I),UDAV(7,I)
  110    CONTINUE
      WRITE(51,9049)
      IF (LDEP.NE.1)  GO TO 130
      WRITE(51,9061)
      WRITE(51,9062)
      WRITE(51,9063)
      WRITE(51,9013)
      DO 120 I=NOL,NOU
         DO 120 J=NRL,NRU
            WRITE(51,9064) I,IDIST(J),VDCOEF(I,J)
  120       CONTINUE
      IF (LTAB.EQ.1) GO TO 150
  130 WRITE(51,9052)
      WRITE(51,9053)
      WRITE(51,9054)
      IF (LORT.EQ.0) GO TO 140
      WRITE(51,9055)
      WRITE(51,9056)
      WRITE(51,9013)
      GO TO 150
  140 WRITE(51,9057)
      WRITE(51,9013)
  150 CONTINUE
      DO 170 J=1,NUMST
         DO 160 I=1,NNUCS
  160       REL(J,I)=REL(J,I)*3.17098E4
  170    CONTINUE
C---END OF INPUT ROUTINE
C
C---THIS SUBROUTINE CALCULATES AIR CONCENTRATION(ACON)
C---AND GROUND DEPOSITION RATE(GCON)
      DO 180 K=1,20
         DO 180 J=1,20
            DO 180 I=1,36
               AVON(J,K)=0.
               ACON(I,J,K)=0.
  180          GCON(I,J,K)=0.
C-----IF(EXP(-(ANLAM(I)*SQRT(2*10*SQSD**2)/(2*8.64E4)).LT.0.99))
C-----REDUCES TO
C-----IF(ANLAM(I).GT.(122.188054/SQSD))
      DISTG=122.188054/SQSD
C
C-----THIS BLOCK EXAMINES CERTAIN INPUT VALUES FOR EQUALITY.  IF THEY
C-----ARE EQUAL, THEN MUCH OF THE FOLLOWING CALCULATION NEED NOT BE
C-----PERFORMED FOR THAT NUCLIDE.  NOMA IS THE ARRAY OF FLAGS THAT
C-----EQUALITY HAS BEEN FOUND & WITH WHICH NUCLIDE.
C
      DO 190 I=2,NNUCS
         IEN=I-1
         DO 190 M=1,IEN
            IF (REL(1,M).EQ.0) GO TO 190
            IF (VD(I).NE.VD(M)) GO TO 190
            IF (VG(I).NE.VG(M)) GO TO 190
            IF (SC(I).NE.SC(M)) GO TO 190
            IF (ANLAM(I).GT.DISTG) GO TO 190
            IF (ANLAM(M).GT.DISTG) GO TO 190
            NOMA(I)=M
            M=IEN
  190       CONTINUE
      IF (LORT.EQ.1.AND.NOU.GT.16) STOP10
C
C-----THIS BLOCK LOOPS THRU THE GRID COVERING THE AREA AROUND THE PLANT.
C
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      DO 680 NO=NOL,NOU                                                 CONC1150
         DO 200 I=1,NNUCS                                               CONC1155
            IF (LDEP.NE.1) GO TO 210                                    CONC1160
            DO 200 J=1,NUMST                                            CONC1165
               DO 200 K=1,7                                             CONC1170
                  FDSTOR(I,J,K) =1                                      CONC1175
  200             CONTINUE                                              CONC1180
  210    DO 670 NR=NRL,NRU                                              CONC1185
            JFLAG=0                                                     CONC1190
            DO 220 I=1,NNUCS                                            CONC1195
               TAI(I)=0.                                                CONC1200
  220          TGD(I)=0.                                                CONC1205
            IF (LORT.EQ.1) GO TO 240                                    CONC1210
C-----ROUTINE TO REFINE THE 4 BY 4 BLOCK OF SQUARES AT THE CENTER OF THECONC1215
C-----SQUARE GRID BY DIVIDING EACH SQUARE INTO 25 SMALLER SQUARES       CONC1220
            IF (NO.LT.9.OR.NO.GT.12) GO TO 230                          CONC1225
            IF (NR.LT.9.OR.NR.GT.12) GO TO 230                          CONC1230
            JFLAG=1                                                     CONC1235
            DO 610 NOP=1,5                                              CONC1240
               DO 610 NRP=1,5                                           CONC1245
C-----COMPUTE DISTANCE FROM CENTER OF SUBSQUARE TO CENTER OF GRID       CONC1250
                  X=SQRT((11.-NO-(NOP*2.-1.)/10.)**2+(11.-NR-(NRP*2.-1.)CONC1255
     >              /10.)**2) *SQSD                                     CONC1260
C-----EACH SUBSQUARE IS EVALUATED IN DIRECTION THAT IT WOULD BE IN IF ITCONC1265
C-----WERE IN THE SAME POSITION AS A FULL-SIZE SQUARE                   CONC1270
                  MO=NSPTMO(5*(NO-9)+NOP,5*(NR-9)+NRP)                  CONC1275
                  GO TO 250                                             CONC1280
  230             X=SQRT( (10.5-NO)*(10.5-NO)+(10.5-NR)*(10.5-NR) ) *   CONC1285
     >             SQSD                                                 CONC1290
                  MO=NSPTMO(NO,NR)                                      CONC1295
                  GO TO 250                                             CONC1300
  240             X=IDIST(NR)                                           CONC1305
                  MO=NO                                                 CONC1310
  250             XO=X                                                  CONC1315
                  THETA=1.0                                             CONC1320
                  M=0                                                   CONC1325
C                                                                       CONC1330
C-----THIS BLOCK LOOPS THRU THE STACKS (EMISSION POINTS).               CONC1335
C                                                                       CONC1340
                  DO 600 J=1,NUMST                                      CONC1345
                     IF (LARE.EQ.0) GO TO 290                           CONC1350
C                                                                       CONC1355
C-----AREA SOURCE BLOCK (BY CHRISTOPHER B. NELSON,EPA).                 CONC1360
C                                                                       CONC1365
C... CONSIDER SOURCES TO BE POINT SOURCES IF LESS THAN 10 METERS        CONC1370
C... DIAM. OR IF RATIO OF DISTANCE X TO THE DIAM. IS GREATER THAN 2.5.  CONC1375
C                                                                       CONC1380
                     TESTAR=X/(DIM(J)+.00001)                           CONC1385
                     IF (DIM(J).LT.10..OR.TESTAR.GT.2.5) GO TO 290      CONC1390
C                                                                       CONC1395
C... RO IS THE RADIUS OF THE SOURCE.                                    CONC1400
C... R1 IS THE INNER RADIUS OF THE TRANSFORMED SOURCE.                  CONC1405
C... R2 IS THE OUTER RADIUS OF THE TRANSFORMED SOURCE.                  CONC1410
C... X IS THE EFFECTIVE DISTANCE FOR CALCULATING CHI/Q.                 CONC1415
C... THETA IS THE ANGULAR WIDTH IN SECTORS OF THE TRANSFORMED SOURCE.   CONC1420
C... (MULTIPLY THETA BY PI/8.0 TO CONVERT THETA TO RADIANS.)            CONC1425
C... 0.88622693=SQRT(PI/4.)                                             CONC1430
C... 2.5198421=4.0**(2/3)                                               CONC1435
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C... 4.5135167=8./SQRT(PI)                                              CONC1440
C                                                                       CONC1445
                     R0=DIM(J)/2.0                                      CONC1450
                     IF (X0.GT.0.88622693*R0) GO TO 270                 CONC1455
                     IF (X0.GT.0.5*R0) GO TO 260                        CONC1460
C                                                                       CONC1465
C... 0.LE.X0.LE.R0/2.                                                   CONC1470
                     R1=0.                                              CONC1475
                     R2=R0                                              CONC1480
                     X=R2/2.5198421                                     CONC1485
                     THETA=16.                                          CONC1490
                     GO TO 280                                          CONC1495
C                                                                       CONC1500
C... R0/2.LT.X0.LE.R0*SQRT(PI/4.)                                       CONC1505
  260                R1=0.                                              CONC1510
                     R2=2.*X0                                           CONC1515
                     X=R2/2.5198421                                     CONC1520
                     THETA=4.0*(R0/X0)**2                               CONC1525
                     GO TO 280                                          CONC1530
C                                                                       CONC1535
C... R0*SQRT(PI/4).LT.X0                                                CONC1540
  270                R1=X0-0.88622693*R0                                CONC1545
                     R2=X0+0.88622693*R0                                CONC1550
                     X=(X0*(SQRT(R2)+SQRT(R1))/2.0)**0.66666667         CONC1555
                     THETA=4.5135167*R0/X0                              CONC1560
C                                                                       CONC1565
C... M IS THE NUMBER OF SECTORS ON EACH SIDE OF MO WHICH                CONC1570
C... INCLUDE THE TRANSFORMED SOURCE.                                    CONC1575
  280                M=INT(THETA/2.0+0.5)                               CONC1580
C... DTHETA IS THE ANGULAR WIDTH OF THE TRANSFORMED SOURCE IN THE FIRST CONC1585
C... AND LAST SECTORS.                                                  CONC1590
                     DTHETA=AMOD((THETA/2.0+0.5),1.0)                   CONC1595
                     IF (DTHETA.GT.0.) GO TO 290                        CONC1600
                     M=M-1                                              CONC1605
                     DTHETA=1.0                                         CONC1610
  290                IF (M.EQ.0) DTHETA=THETA                           CONC1615
C... LL IS THE TOTAL NUMBER OF SECTORS WHICH CONTRIBUTE TO CHI/Q.       CONC1620
                     LL=2*M+1                                           CONC1625
C... L1 IS THE INITIAL SECTOR.                                          CONC1630
                     L1=MOD(MO-M+15,16)+1                               CONC1635
                     DO 580 L=1,LL                                      CONC1640
                        MO=MOD(L1+L+14,16)+1                            CONC1645
                        IF (L.EQ.1.OR.L.EQ.LL) GO TO 300                CONC1650
                        PERW=PERD(MO)/THETA                             CONC1655
                        GO TO 310                                       CONC1660
  300                   PERW=PERD(MO)*DTHETA/THETA                      CONC1665
C                                                                       CONC1670
C-----END OF AREA SOURCE BLOCK.                                         CONC1675
C                                                                       CONC1680
C-----THIS BLOCK LOOPS THRU THE 7 PASQUILL AIR STABILITY CATEGORIES.    CONC1685
C                                                                       CONC1690
  310                   DO 580 JH=1,7                                   CONC1695
                           IF (FRAW(JH,MO).EQ.0) GO TO 580              CONC1700
                           U = UDAV(JH,MO)                              CONC1705
                           UD=UDCAT(JH,MO)                              CONC1710
                           IF (U.GT.6.OR.U.LT.1.) GO TO 320             CONC1715
                           FF2=(1.167-U/6.-1./UD) / (1.167-U/6.-1./U)   CONC1720
                           FF3=((U-1.)*(1.-FF2))/5.                     CONC1725
                           FF1=1.-FF2-FF3                               CONC1730
                           GO TO 330                                    CONC1735
 320                       FF1=0.                                       CONC1740
                           FF2=1.                                       CONC1745
                           FF3=0.                                       CONC1750
C-----THIS BLOCK CALCULATES PLUME RISE                                  CONC1755
C-----RISE=0..BRIGGS' EQUATIONS FOR BUOYANT PLUMES                      CONC1760
C-----RISE=1..RUPP'S EQUATIONS FOR MOMENTUM-TYPE EMISSIONS              CONC1765
C-----RISE=2..READ PLUME RISE FROM CARDS                                CONC1770
 330                       IF (LRISE.EQ.1) GO TO 360                    CONC1775
                           IF (LRISE.EQ.2) GO TO 370                    CONC1780
                           IF (LRISE.NE.0) STOP11                       CONC1785
                           IF (JH.GT.4) GO TO 340                       CONC1790
                           IF (X.LE.10.*PH(J)) GO TO 350                CONC1795
                           H =PH(J)+(1.6/U*( (.0037000*QH(J)*PH(J)*PH(J)CONC1800
    >                       )** .33333333))                             CONC1805
                           GO TO 380                                    CONC1810
 340                       S=9.80665/TA*(TG(JH-4)+.0098)                CONC1815
                           IF (X.LE.2.4*U/SQRT(S)) GO TO 350            CONC1820
                           H =PH(J)+(2.9*( (.000037*QH(J)/U/S)**        CONC1825
    >                       .33333333 ) )                               CONC1830
                           GO TO 380                                    CONC1835
 350                       H =PH(J)+(1.6/U*( (.000037*QH(J)*X*X)**      CONC1840
    >                       .33333333 ))                                CONC1845
                           GO TO 380                                    CONC1850
 360                       H =PH(J)+1.5*VEL(J)*DIA(J)/U                 CONC1855
                           GO TO 380                                    CONC1860
 370                       H =PH(J)+PR(JH)                              CONC1865
C     END OF PLUME RISE CALCULATIONS                                    CONC1870
 380                       NX=1                                         CONC1875
                           IF (X.GT.1000) NX=2                          CONC1880
                           IF (X.GT.3000) NX=3                          CONC1885
                           IF (X.GT.10000) NX=4                         CONC1890
                           A=AA(JH,NX,1)                                CONC1895
                           C=AA(JH,NX,2)                                CONC1900
                           D=AA(JH,NX,3)                                CONC1905
                           F=AA(JH,NX,4)                                CONC1910
C                                                                       CONC1915
C-----THIS BLOCK LOOPS THRU THE DIFFERENT NUCLIDES RELEASED IN THE PLUMECONC1920
C                                                                       CONC1925
                           DO 570 I=1,NNUCS                             CONC1930
                              IF (NOMA(I).GT.0.AND.J.EQ.1) GO TO 570    CONC1935
C-----DETERMINE XLIDO (VALUE OF X WHERE LID AFFECTS VERTICAL DISPERSION)CONC1940
                              Y1=0.                                     CONC1945
                              Y2=10000.                                 CONC1950
                              DO 410 IX1=1,3                            CONC1955
                                 DO 390 IX2=1,10                        CONC1960
                                    Y=Y1+Y2*IX2                         CONC1965
                                    IF (Y**D.GT.(.47*F*(LID1+Y*VG(I)/UD)CONC1970
    >                                )) GO TO 400                       CONC1975
 390                                CONTINUE                            CONC1980
 400                             Y1=Y1+Y2*(IX2-1)                       CONC1985
 410                             Y2=Y2/10.                              CONC1990
                              XLIDO=2.*Y                                CONC1995
C-----THIS BLOCK FINDS DEPLETION FRACTION                               CONC2000
                              VD1=VD(I)                                 CONC2005
C-----SECTION TO FIND DEPLETION IF BY VARIABLE DEPOSITION               CONC2010
C-----LDEP=1 IS OPTION FOR VARIABLE DEPOSITION VELOCITY                 CONC2015
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C-----BOUND(NR) IS THE LOWER BOUND ON THE INTERVAL OF INTEGRATION       CONC2020
C-----BOUND(NR+1) IS THE UPPER BOUND                                    CONC2025
                              IF (LDEP.NE.1) GO TO 480                  CONC2030
                              VD1=VD1*VDCOEF(NO,NR)                     CONC2035
                              IF (X.GT.XLIDO) GO TO 420                 CONC2040
                              CALL QX(BOUND(NR),X,U,UD,H,VD1,VG(I),JH,  CONC2045
     >                         FDD)                                     CONC2050
                              GO TO 440                                 CONC2055
  420                         IF (BOUND(NR).GE.XLIDO) GO TO 430         CONC2060
                              CALL QX(BOUND(NR),XLIDO,U,UD,H,VD1,VG(I), CONC2065
     >                         JH, FDD)                                 CONC2070
                              FDD=FDD*EXP(-((X-XLIDO)*VD1/(LID1*UD)))   CONC2075
                              GO TO 440                                 CONC2080
  430                         FDD=FDD*EXP(-((X-BOUND(NR))*VD1/(LID1*UD))CONC2085
     >                         )                                        CONC2090
  440                         FDD=FDD*FDSTOR(I,J,JH)                    CONC2095
                              IF (X.EQ.BOUND(NR+1)) FDSTOR(I,J,JH)=FDD  CONC2100
                              IF (X.EQ.BOUND(NR+1)) GO TO 530           CONC2105
                              IF (BOUND(NR+1).GT.XLIDO) GO TO 450       CONC2110
                              CALL QX(X,BOUND(NR+1),U,UD,H,VD1,VG(I),JH,CONC2115
     >                          FD1)                                    CONC2120
                              GO TO 470                                 CONC2125
  450                         IF (X.GT.XLIDO) GO TO 460                 CONC2130
                              CALL QX(X,XLIDO,U,UD,H,VD1,VG(I),JH,FD1)  CONC2135
                              FD1=FD1*EXP(-((BOUND(NR+1)-XLIDO)*VD1/    CONC2140
     >                         (LID1* UD)))                             CONC2145
                              GO TO 470                                 CONC2150
  460                         FD1=EXP(-((BOUND(NR+1)-XLIDO)*VD1/(LID1*  CONC2155
     >                         UD)))                                    CONC2160
  470                         FDSTOR(I,J,JH)=FDD*FD1                    CONC2165
                              GO TO 530                                 CONC2170
C-----END VARIABLE DEPOSITION SECTION                                   CONC2175
C-----SECTION FOR DEPLETION IF BY CONSTANT DEPOSITION                   CONC2180
  480                         IF (X.GT.XLIDO) GO TO 500                 CONC2185
                              IF (VG(I).NE.0) GO TO 490                 CONC2190
                              CALL QY(0,X,U,UD,H,VD1,VG(I),JH,FDD)      CONC2195
                              GO TO 530                                 CONC2200
  490                         CONTINUE                                  CONC2205
                              CALL QX(0,X,U,UD,H,VD1,VG(I),JH,FDD)      CONC2210
                              GO TO 530                                 CONC2215
  500                         CONTINUE                                  CONC2220
                              IF (VG(I).NE.0) GO TO 510                 CONC2225
                              CALL QY(0,XLIDO,U,UD,H,VD1,VG(I),JH,FDD)  CONC2230
                              GO TO 520                                 CONC2235
  510                         CONTINUE                                  CONC2240
                              CALL QX(0,XLIDO,U,UD,H,VD1,VG(I),JH,FDD)  CONC2245
  520                         CONTINUE                                  CONC2250
                              FDD=FDD*EXP(-((X-XLIDO)*VD1/(LID1*UD)))   CONC2255
C-----END CONSTANT DEPOSITION SECTION                                   CONC2260
  530                         CONTINUE                                  CONC2265
C-----END DEPLETION FRACTION BLOCK                                      CONC2270
                              QRED=-ANLAM(I)*X/86400.                   CONC2275
                              QRED=REL(J,I)*FDD*(FF1*EXP(-SC(I)*X)+FF2* CONC2280
     >                         EXP(-SC(I)*X/U)+FF3*EXP (-SC(I)*X/6.))*  CONC2285
     >                         (FF1* EXP(QRED)+FF2*EXP(QRED/U)+FF3*     CONC2290
     >                         EXP(QRED/6.))                            CONC2295
                              CHAD=QRED/(6.2832*((X**A)/C)*((X**D)/F)*  CONC2300
     >                         UD)                                      CONC2305
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                              IF ((VG(I)*X)/UD.GE.H) H=(VG(I)*X)/UD     CONC2310
                              IF ((.5*((((VG(I)*X)/UD)+H)/((X**D)/F))**CONC2315
     >                         2)).GT.50) BX=0                          CONC2320
                              IF ((.5*((((VG(I)*X)/UD)+H)/((X**D)/F))**CONC2325
     >                         2)).GT.50) GO TO 540                     CONC2330
                              BX=CHAD*(EXP(-.5*(((((VG(I)*X)/UD)-H)/((X*CONC2335
     >                         *D) /F))**2))+ EXP(-.5*(((((-VG(I)*X)/UD)CONC2340
     >                         +H)/ ((X**D)/F))**2)))                   CONC2345
  540                         BT=BX                                     CONC2350
                              BU=0                                      CONC2355
                              VERT=QRED/(2.5066*((X**A)/C)*LID1*UD)     CONC2360
                              IF (X.LE.XLIDO) GO TO 550                 CONC2365
                              BT=VERT                                   CONC2370
                              BU=BT                                     CONC2375
                              VERT=0                                    CONC2380
  550                         FRAC=(6.300835*((X**A)/C))/X              CONC2385
                              IF (LOST.EQ.1) FRAC=1.                    CONC2390
  560                         FRAC=FRAC*PERW                            CONC2395
                              VERT=FRAC*VERT                            CONC2400
                              BU =FRAC*BU                               CONC2405
                              BT =FRAC*BT                               CONC2410
                              IF (I.EQ.1) AVON(NO,NR)=(FRAW(JH,MO)*     CONC2415
     >                         (VERT+BU))/1000000.+AVON(NO,NR)          CONC2420
                              TGD(I)=TGD(I)+FRAW(JH,MO)*(VD1*BT+SC(I)*  CONC2425
     >                         LID1* (VERT+BU))                         CONC2430
                              TAI(I)=TAI(I)+FRAW(JH,MO)*BT              CONC2435
  570                         CONTINUE                                  CONC2440
C-----END OF NUCLIDE LOOP-----------------------------------------------CONC2445
  580                      CONTINUE                                     CONC2450
C-----END OF PASQUILL CATAGORY LOOP-------------------------------------CONC2455
                     DO 590 I=1,NNUCS                                   CONC2460
                        M=NOMA(I)                                       CONC2465
                        IF (M.LE.0.OR.J.GT.1) GO TO 590                 CONC2470
                        TGD(I)=TGD(M)*REL(J,I)/REL(J,M)                 CONC2475
                        TAI(I)=TAI(M)*REL(J,I)/REL(J,M)                 CONC2480
  590                   CONTINUE                                        CONC2485
  600                CONTINUE                                           CONC2490
C-----END OF STACK LOOP-------------------------------------------------CONC2495
                  IF (JFLAG.NE.1) GO TO 630                             CONC2500
  610             CONTINUE                                              CONC2505
C-----FIND AVERAGE OF CONCENTRATIONS OF SUBSQUARES                      CONC2510
            DO 620 I=1,NNUCS                                            CONC2515
               TGD(I)=TGD(I)/25.                                        CONC2520
               TAI(I)=TAI(I)/25.                                        CONC2525
  620          CONTINUE                                                 CONC2530
            AVON(NO,NR)=AVON(NO,NR)/25.                                 CONC2535
  630       IF (LDEP.EQ.1.AND.LIST(NR).EQ.1) GO TO 670                  CONC2540
            IF (LORT.EQ.1) GO TO 650                                    CONC2550
            DO 640 I=1,NNUCS                                            CONC2555
               ACON(I,NO,NR)=TAI(I)/1000000.                            CONC2560
               GCON(I,NO,NR)=TGD(I)/10000.                              CONC2565
               VD1=VD(I)                                                CONC2570
               DRYCON=ACON(I,NO,NR)*VD1*100                             CONC2575
               WETCON=(GCON(I,NO,NR)-DRYCON)*(SC(I)/(SC(I)+1.E-30))     CONC2580
      IF (LTAB.EQ.1) GO TO 670                                          CONC2584
  640          WRITE(51,9058) NO,NR,NAMNUC(I),ACON(I,NO,NR),DRYCON,     CONC2585
     >          WETCON, GCON(I,NO,NR)                                   CONC2590
            GO TO 670                                                   CONC2595
  650        DO 660 I=1,NNUCS                                            CONC2600
                ACON(I,NO,NR)=TAI(I)/1000000.                            CONC2605
                GCON(I,NO,NR)=TGD(I)/10000.                              CONC2610
                VD1=VD(I)                                                CONC2615
                IF (LDEP.EQ.1) VD1=VD1*VDCOEF(NO,NR)                     CONC2620
                DRYCON=ACON(I,NO,NR)*VD1*100                             CONC2625
                WETCON=(GCON(I,NO,NR)-DRYCON)*(SC(I)/(SC(I)+1.E-30))     CONC2630
      IF (LTAB.EQ.1) GO TO 670                                           CONC2634
  660           WRITE(51,9058) NO,IDIST(NR),NAMNUC(I),ACON(I,NO,NR),     CONC2635
     >           DRYCON,WETCON, GCON(I,NO,NR)                            CONC2640
  670        CONTINUE                                                    CONC2645
  680     CONTINUE                                                       CONC2650
      IF (LCHI.EQ.1) GO TO 690                                           CONC2655
      IF (LORT.EQ.1) CALL CHIQ                                           CONC2660
  690 IF (LPUN.EQ.0) GO TO 710                                           CONC2665
      DO 700 I=1,LPUN                                                    CONC2670
         PUNCH 9065,((ACON(I,NO,NR),NR=1,20),NO=1,20)                    CONC2675
         PUNCH 9065,((GCON(I,NO,NR),NR=1,20),NO=1,20)                    CONC2680
  700    CONTINUE                                                        CONC2685
  710 CONTINUE                                                           CONC2690
      IF (LORT.EQ.1) GO TO 720                                           CONC2695
      ASQSD=((SQSD**2)*400.)/1.E6                                        CONC2700
      WRITE(51,9001)                                                     CONC2705
      WRITE(51,9002)ASQSD                                                CONC2710
      WRITE(51,9003)                                                     CONC2715
      WRITE(51,9004)SQSD                                                 CONC2720
      WRITE(51,9005)                                                     CONC2725
      WRITE(51,9006)                                                     CONC2730
      WRITE(51,9007)                                                     CONC2735
C-----END OF GRID LOOP---------------------------------------------------CONC2740
  720 RETURN                                                             CONC2745
 9000 FORMAT(F10.0)                                                      CONC2755
 9001 FORMAT('1',T30,'NOTE-THE AREA SURROUNDING THE PLANT IS A SQUARE    CONC2760
     >WITH AN AREA')                                                     CONC2765
 9002 FORMAT(' ',T35,'OF',F10.1,1X,                                      CONC2770
     > 'SQUARE KILOMETERS WITH THE PLANT AT THE CENTER.')                CONC2775
 9003 FORMAT(' ',T35,'THE SQUARE AREA IS ALIGNED DUE NORTH-SOUTH AND EASCONC2780
     >T-WEST. THE')                                                      CONC2785
 9004 FORMAT(' ',T35,'400 SMALLER SQUARES, WHICH ARE EACH ',F7.1,1X,     CONC2790
     > 'METERS ON A SIDE,')                                              CONC2795
 9005 FORMAT(' ',T35,'ARE IDENTIFIED BY COLUMN AND ROW. COLUMNS ARE NUMBCONC2800
     >ERED FROM')                                                        CONC2805
 9006 FORMAT(' ',T35,'1 TO 20 FROM WEST TO EAST. ROWS ARE NUMBERED FROM CONC2810
     >1 TO 20 FROM')                                                     CONC2815
 9007 FORMAT(' ',T35,'SOUTH TO NORTH.')                                  CONC2820
 9008 FORMAT(8I10)                                                       CONC2825
 9009 FORMAT(8F10.0)                                                     CONC2830
 9010 FORMAT(16F5.0)                                                     CONC2835
 9011 FORMAT(A8)                                                         CONC2840
 9012 FORMAT(7F10.0)                                                     CONC2845
 9013 FORMAT('0')                                                        CONC2850
 9014 FORMAT(' ',T30,'A',F10.1,'   B',F10.1,'   C',F10.1,'   D',F10.1,   CONC2855
     > '   E',F10.1,'   F',F10.1,'   G',F10.1)                           CONC2860
 9015 FORMAT('1',T20,'METEOROLOGICAL AND PLANT INFORMATION SUPPLIED TO PCONC2865
     >ROGRAM----')                                                       CONC2870
 9016 FORMAT('0',T30,'AVERAGE AIR TEMPERATURE (DEG K)',T100,F10.1)       CONC2875
 9017 FORMAT('0',T30,'AVERAGE VERTICAL TEMPERATURE GRADIENT OF THE AIR (CONC2880
     >DEG K/METER)')                                                     CONC2885
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9018 FORMAT('0',T40,'IN STABILITY CLASS E',T100,F10.4)
9019 FORMAT('0',T40,'IN STABILITY CLASS F',T100,F10.4)
9020 FORMAT('0',T40,'IN STABILITY CLASS G',T100,F10.4)
9021 FORMAT('0',T30,'HEIGHT OF LID (METERS)',T100,I10)
9022 FORMAT('0',T30,'RAINFALL RATE (CM/YEAR)',T100,F10.2)
9023 FORMAT('0',T30,'NUMBER OF STACKS IN THE PLANT',T100,I10)
9024 FORMAT('0',T30,'STACK INFORMATION--')
9025 FORMAT('0',T89,'STACK NUMBER')
9026 FORMAT('0',T70,'1',T80,'2',T90,'3',T100,'4',T110,'5',T120,'6')
9027 FORMAT('0',T20,'HEIGHT (METERS)',T62,6F10.4)
9028 FORMAT('0',T20,'DIAMETER (METERS)',T62,6F10.4)
9029 FORMAT('0',T20,'EFFLUENT VELOCITY (METERS/SEC)',T62,6F10.4)
9030 FORMAT('0',T20,'RATE OF HEAT EMISSION (CAL/SECOND)',T62,6E10.2)
9031 FORMAT('1',T26,'FREQUENCY OF ATMOSPHERIC STABILITY CLASSES FOR EAC
     >H DIRECTION')
9032 FORMAT('0',T7,'SECTOR',T40,
     > 'FRACTION OF TIME IN EACH STABILITY CLASS')
9033 FORMAT('0',T25,'A',T37,'B',T49,'C',T61,'D',T73,'E',T85,'F',T97,
     > 'G')
9034 FORMAT(' ',T7,I4,T23,F6.4,T35,F6.4,T47,F6.4,T59,F6.4,T71,F6.4,
     > T83,F6.4,T95,F6.4)
9035 FORMAT('1',T50,'RELEASE RATES FOR RADIONUCLIDES')
9036 FORMAT('0',T45,'STACK',T61,'NUCLIDE',T80,'RELEASE RATE')
9037 FORMAT(' ',T80,'(CURIES/YEAR)')
9038 FORMAT(' ',T45,I2,T63,A8,T80,E10.3)
9039 FORMAT('1',T46,'PLUME DEPLETION AND DEPOSITION PARAMETERS')
9040 FORMAT('0',T20,'NUCLIDE',T40,'GRAVITATIONAL',T60,
     > 'DEPOSITION VELOCITY',T85,'SCAVENGING',T100,
     > 'EFFECTIVE DECAY CONSTANT')
9041 FORMAT(' ',T40,'FALL VELOCITY',T85,'COEFFICIENT',T108,'IN PLUME')
9042 FORMAT(' ',T41,'(METERS/SEC)',T63,'(METERS/SEC)',T87,'(1/SEC)',
     > T108,'(PER DAY)')
9043 FORMAT(' ',T21,A8,T37,F10.3,T61,F10.5,T85,E10.3,T107,E10.3)
9044 FORMAT('1',T36,'FREQUENCIES OF WIND DIRECTIONS AND RECIPROCAL-AVER
     >AGED WIND SPEEDS')
9045 FORMAT('0',T20,'WIND TOWARD',T50,'FREQUENCY',T82,
     > 'WIND SPEEDS FOR EACH STABILITY CLASS')
9046 FORMAT(' ',T94,'(METERS/SEC)')
9047 FORMAT('0',T73,'A',T81,'B',T90,'C',T99,'D',T108,'E',T116,'F',T124,
     >  'G')
9048 FORMAT(' ',T25,I2,T52,F5.3,T71,F5.2,T79,F5.2,T88,F5.2,T97,F5.2,
     > T106,F5.2,T114,F5.2,T122,F5.2)
9049 FORMAT('0',T20,'WIND DIRECTIONS ARE NUMBERED COUNTERCLOCKWISE STAR
     >TING AT 1 FOR DUE NORTH')
9050 FORMAT('1',T38,'FREQUENCIES OF WIND DIRECTIONS AND TRUE-AVERAGE WI
     >ND SPEEDS')
9051 FORMAT(' ',T25,I2,T52,F5.3,T71,F5.2,T79,F5.2,T88,F5.2,T97,F5.2,
     > T106,F5.2,T114,F5.2,T122,F5.2)
9052 FORMAT('1',T46,'ESTIMATED RADIONUCLIDE CONCENTRATIONS')
9053 FORMAT('0',T10,'AREA',T30,'NUCLIDE',T42,'AIR CONCENTRATION',T64,
     > 'DRY DEPOSITION RATE',T88,'WET DEPOSITION RATE',T112,
     > 'GROUND DEPOSITION RATE')
9054 FORMAT(T47,'(PCI/CC)',T64,'(PCI/SQUARE CM-SEC)',T88,
     > '(PCI/SQUARE CM-SEC)',T113,'(PCI/SQUARE CM-SEC)')
9055 FORMAT(' WIND TOWARD',T17,'DISTANCE')
9056 FORMAT(' ',T17,'(METERS)')
9057 FORMAT(' ',T4,'COLUMN',T21,'ROW')
9058 FORMAT(' ',T6,I2,T18,I6,T31,A8,T45,E10.3,T68,E10.3,T92,E10.3,T118,
     >  E10.3)                                                          CONC3180
 9059 FORMAT(10F8.4)                                                    CONC3185
 9060 FORMAT(20I1)                                                      CONC3190
 9061 FORMAT('1',T50,'DEPOSITION VELOCITY COEFFICIENTS')                CONC3195
 9062 FORMAT('0',T37,'DIRECTION',T55,'DISTANCE',T72,                    CONC3200
     > 'DEPOSITION COEFFICIENT')                                        CONC3205
 9063 FORMAT(' ',T55,'(METERS)',T78,'(NO UNITS)')                       CONC3210
 9064 FORMAT(' ',T40,I2,T57,I6,T78,F8.4)                                CONC3215
 9065 FORMAT(8E10.4)                                                    CONC3220
 9066 FORMAT('0',T20,'DIAMETER OF AREA SOURCE (METERS)',T62,6F10.4)     CONC3225
      END                                                               CONC3230
      SUBROUTINE QY(BND,X,U,UD,HS,VD,VG,INDEX1,QXR)
C
C       R. E. MOORE   HEALTH AND SAFETY RESEARCH DIV.,  ORNL  3-1-78
C
C       A TABLE CALLOUT SUBROUTINE FOR DETERMINING DEPLETION FRACTIONS F
C       DEPOSITION FOR CONSTANT DEPOSITION VELOCITY AND FOR ZERO GRAVITA
C       EFFECT.
C
C       TABULATED VALUES IN DATA STATEMENT WERE DERIVED THROUGH THE USE
C       SUBROUTINE QX, A SIMPSON'S RULE SUBROUTINE WRITTEN ORIGINALLY BY
C       D. E. DUNNING, MODIFIED BY J. F. HULL, AND LATER CHANGED BY
C       D. P. STEWART.
C
      COMMON /QCOM/ REFA(34,7,20)
      DIMENSION XIDI(20),KP(34)
      REAL KP
      INTEGER IDOM
      DATA XIDI/35.,65.,100.,150.,200.,300.,400.,500.,650.,800.,1000.,
     > 1500.,2000.,4000.,7000.,10000.,25000.,60000.,90000.,200000./
      DATA KP/1.,1.5,2.,3.,4.,5.,6.,7.,8.,9.,10.,12.5,15.,17.5,20.,25.,
     > 30.,35.,40.,50.,60.,70.,80.,90.,100.,120.,140.,160.,180.,200.,
     > 240.,260.,300.,400./
      IF (IDOM.EQ.121) GO TO 20
   10 CALL QY1
      CALL QY2
      CALL QY3
      IDOM=121
   20 JH=INDEX1
      H1=HS
      DO 30 ID=1,20
         IF (X.LT.XIDI(ID)) GO TO 50
   30    CONTINUE
   40 ID2=35
      GO TO 60
   50 ID1=ID
      ID2=ID-1
   60 DO 70 KR=1,34
         IF (H1.LT.KP(KR)) GO TO 90
   70    CONTINUE
   80 KP2=21
      GO TO 100
   90 KP1=KR
      KP2=KR-1
  100 IF (KP2.EQ.0.AND.ID2.EQ.0) GO TO 140
      IF (KP2.EQ.0) GO TO 150
      IF (ID2.EQ.0) GO TO 170
      IF (X.GE.200000.) GO TO 110
      IF (H1.GE.400.) GO TO 130
      CUX1=REFA(KP1,JH,ID2)-((REFA(KP1,JH,ID2)-REFA(KP1,JH,ID1))* ((X-
     > XIDI(ID2))/(XIDI(ID1)-XIDI(ID2))))
      CUX2=REFA(KP2,JH,ID2)-((REFA(KP2,JH,ID2)-REFA(KP2,JH,ID1))* ((X-
     > XIDI(ID2))/(XIDI(ID1)-XIDI(ID2))))
      CUXA=CUX1-(((CUX1-CUX2)*(KP(KP1)-H1))/(KP(KP1)-KP(KP2)))
      GO TO 190
  110 IF (H1.GT.400.) GO TO 120
      CUX1=X*((REFA(KP1,JH,20)-REFA(KP1,JH,19))/110000.)+ (REFA(KP1,JH,
     > 19)-.8181818*(REFA(KP1,JH,20)-REFA(KP1,JH,19)))
      CUX2=X*((REFA(KP2,JH,20)-REFA(KP2,JH,19))/110000.)+ (REFA(KP2,JH,
     > 19)-.8181818*(REFA(KP2,JH,20)-REFA(KP2,JH,19)))
      CUXA=CUX1-(((CUX1-CUX2)*(KP(KP1)-H1))/(KP(KP1)-KP(KP2)))
      GO TO 190
  120 CUM1=H1*((REFA(34,JH,20)-REFA(33,JH,20))/100.)+4.*REFA(33,JH,20)-
     > 3.*REFA(34,JH,20)
      CUM2=H1*((REFA(34,JH,19)-REFA(33,JH,19))/100.)+4.*REFA(33,JH,19)-
     > 3.*REFA(34,JH,19)
      CUXA=((CUM1-CUM2)/110000.)*X+CUM1-1.8181818*(CUM1-CUM2)
      GO TO 190
  130 CUX1=H1*((REFA(34,JH,ID1)-REFA(33,JH,ID1))/100.)+4.*REFA(33,JH,
     > ID1)-3.*REFA(34,JH,ID1)
      CUX2=H1*((REFA(34,JH,ID2)-REFA(33,JH,ID2))/100.)+4.*REFA(33,JH,
     > ID2)-3.*REFA(34,JH,ID2)
      CUXA=((CUX2-CUX1)/(XIDI(ID2)-XIDI(ID1)))*(X-XIDI(ID1))+CUX1
      GO TO 190
  140 CUXA=1.-(1.-REFA(1,JH,1)*(X/XIDI(1)))
      GO TO 190
  150 IF (X.GE.200000.) GO TO 160
      CUXA=REFA(1,JH,ID2)-((REFA(1,JH,ID2)-REFA(1,JH,ID1))* ((X-
     > XIDI(ID2))/(XIDI(ID1)-XIDI(ID2))))
      GO TO 190
  160 CUXA=((REFA(1,JH,20)-REFA(1,JH,19))/110000.)*X+REFA(1,JH,20)-
     > 1.8181818*(REFA(1,JH,20)-REFA(1,JH,19))
      GO TO 190
  170 IF (H1.GT.400.) GO TO 180
      CUX1=1.-(1.-REFA(KP1,JH,1)*(X/XIDI(1)))
      CUX2=1.-(1.-REFA(KP2,JH,1)*(X/XIDI(1)))
      CUXA=CUX1-(((CUX1-CUX2)*(KP(KP1)-H1))/(KP(KP1)-KP(KP2)))
      GO TO 190
  180 CUX1=1.-((1.-REFA(33,JH,1))*(X/XIDI(1)))
      CUX2=1.-((1.-REFA(34,JH,1))*(X/XIDI(1)))
      CUXA=((CUX2-CUX1)/100.)*H1+CUX1-3.*(CUX2-CUX1)
  190 QXR=CUXA**((100.*VD)/UD)
      RETURN
      END
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 SUBROUTINE QY1
 COMMON /QCOM/ REPA(34,7,20)
 DIMENSION SEPA(34,7,20)
 DIMENSION AA(114),AB(114),AC(114),AD(114),AE(114),AF(114),AG(114),
> AH(114),AI(114),AJ(114),AK(114),AL(114),AM(114),AN(114),AO(70)
 EQUIVALENCE (SEPA( 1,1, 1),AA(1)),(SEPA(13,4, 1),AB(1)),(SEPA(25,
> 7, 1),AC(1)),(SEPA( 3,4, 2),AD(1)),(SEPA(15,7, 2),AE(1)),
> (SEPA(27,3, 3),AF(1)),(SEPA( 5,7, 3),AG(1)),(SEPA(17,3, 4),AH(1))
> ,(SEPA(29,6, 4),AI(1)),(SEPA( 7,3, 5),AJ(1)),(SEPA(19,6, 5),AK(1)
> ),(SEPA(31,2, 6),AL(1)),(SEPA( 9,6, 6),AM(1)),(SEPA(21,2, 7),
> AN(1)),(SEPA(33,5, 7),AO(1))
 DATA AA/ .9229E 00,.9370E 00,.9483E 00,.9639E 00,.9728E 00,.9798E
> 00, .9851E 00,.9882E 00,.9919E 00,.9941E 00,.9957E 00,.9982E 00,
> .9991E 00,.9993E 00,.9997E 00,.1000E 01,.1000E 01,.1000E 01,
> .1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,
> .1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,
> .1000E 01,.1000E 01,.1000E 01,.1000E 01,.9051E 00,.9283E 00,
> .9448E 00,.9665E 00,.9790E 00,.9878E 00,.9929E 00,.9959E 00,
> .9978E 00,.9988E 00,.9991E 00,.9997E 00,.1000E 01,.1000E 01,
> .1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,
> .1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,
> .1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,
> .1000E 01,.1000E 01,.8943E 00,.9259E 00,.9476E 00,.9738E 00,
> .9874E 00,.9943E 00,.9976E 00,.9990E 00,.9990E 00,.9996E 00,
> .9999E 00,.1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,
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> .9328E 00,.9380E 00,.9436E 00,.9515E 00,.9581E 00,.9645E 00,      QY1 1255
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> .8062E 00,.8283E 00,.8442E 00,.8568E 00,.8673E 00,.8761E 00,      QY1 1275
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> .9391E 00,.9500E 00,.9597E 00,.9676E 00,.9739E 00,.9832E 00/      QY1 1285
 DATA AN/ .9893E 00,.9933E 00,.9959E 00,.9976E 00,.9986E 00,.9988E QY1 1290
> 00, .9996E 00,.9999E 00,.1000E 01,.1000E 01,.1000E 01,.1000E 01, QY1 1295
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> .8040E 00,.8220E 00,.8370E 00,.8500E 00,.8621E 00,.8716E 00,      QY1 1305
> .8807E 00,.9000E 00,.9157E 00,.9287E 00,.9398E 00,.9569E 00,      QY1 1310
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> .9993E 00,.9995E 00,.9998E 00,.1000E 01,.1000E 01,.1000E 01,      QY1 1320
> .1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,      QY1 1325
> .6157E 00,.6478E 00,.6735E 00,.7146E 00,.7474E 00,.7750E 00,      QY1 1330
> .8000E 00,.8200E 00,.8387E 00,.8555E 00,.8731E 00,.9023E 00,      QY1 1335
> .9268E 00,.9457E 00,.9602E 00,.9797E 00,.9902E 00,.9956E 00,      QY1 1340
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> .1000E 01,.1000E 01,.1000E 01,.1000E 01,.5120E 00,.5618E 00,      QY1 1355
> .6020E 00,.6663E 00,.7174E 00,.7599E 00,.8002E 00,.8267E 00,      QY1 1360
> .8533E 00,.8764E 00,.8960E 00,.9340E 00,.9594E 00,.9758E 00,      QY1 1365
> .9861E 00,.9959E 00,.9988E 00,.9991E 00,.9998E 00,.1000E 01,      QY1 1370
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> .1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,      QY1 1430
> .1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,      QY1 1435
```

```
     > .1000E 01,.1000E 01,.1000E 01,.1000E 01/                         QY1 1440
      DO 30 I=1,34                                                      QY1 1445
         DO 20 K=1,7                                                    QY1 1450
            DO 10 L=1,7                                                 QY1 1455
   10          REPA(I,K,L)=SRPA(I,K,L)                                  QY1 1460
   20       CONTINUE                                                    QY1 1465
   30    CONTINUE                                                       QY1 1470
      RETURN                                                            QY1 1475
      END                                                               QY1 1480
```

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 SUBROUTINE QY2
 COMMON /QCOM/ REFA(34,7,20)
 DIMENSION SEFA(34,7,20)
 DIMENSION BQ(98),BC(114),BD(114),BE(114),BF(114),BG(114),BH(114),
> BI(114),BJ(114),BK(114),BL(114),BM(114),BN(114),BO(114),BP(86)
 EQUIVALENCE (SEFA( 1,1,14),BQ(1)),(SEFA(31,3,14),BC(1)),(SEFA( 9,
> 7,14),BD(1)),(SEFA(21,3,15),BE(1)),(SEFA(33,6,15),BF(1)),
> (SEFA(11,3,16),BG(1)),(SEFA(23,6,16),BH(1)),(SEFA( 1,3,17),BI(1))
> ,(SEFA(13,6,17),BJ(1)),(SEFA(25,2,18),BK(1)),(SEFA( 3,6,18),BL(1)
> ),(SEFA(15,2,19),BM(1)),(SEFA(27,5,19),BN(1)),(SEFA( 5,2,20),
> BO(1)),(SEFA(17,5,20),BP(1))
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> .8143E 00,.8204E 00,.8254E 00, .8298E 00,.8306E 00,.8372E 00,
> .8448E 00,.8509E 00,.8562E 00, .8607E 00,.8685E 00,.8749E 00,
> .8803E 00,.8850E 00,.8930E 00, .8995E 00,.9050E 00,.9098E 00,
> .9141E 00,.9180E 00,.9246E 00, .9303E 00,.9352E 00,.9399E 00,
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> .9219E 00,.9343E 00,.9441E 00/
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> 00, .3726E 00,.3958E 00,.4146E 00,.4309E 00,.4453E 00,.4585E 00,
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> .1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,
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> .9190E 00,.9229E 00,.9295E 00,.9325E 00,.9370E 00,.9483E 00,      QY2  280
> .6364E 00,.6536E 00,.6662E 00,.6845E 00,.6977E 00,.7082E 00,      QY2  285
> .7168E 00,.7242E 00,.7307E 00,.7364E 00,.7416E 00,.7527E 00,      QY2  290
> .7619E 00,.7698E 00,.7767E 00,.7883E 00,.7979E 00,.8062E 00,      QY2  295
> .8133E 00,.8255E 00,.8356E 00,.8442E 00,.8477E 00,.8584E 00,      QY2  300
> .8646E 00,.8749E 00,.8838E 00,.8916E 00,.8973E 00,.9051E 00,      QY2  305
> .9154E 00,.9200E 00,.9283E 00,.9448E 00,.4937E 00,.5129E 00,      QY2  310
> .5273E 00,.5486E 00,.5604E 00,.5772E 00,.5880E 00,.5974E 00,      QY2  315
> .6019E 00,.6131E 00,.6201E 00,.6346E 00,.6470E 00,.6578E 00,      QY2  320
> .6675E 00,.6820E 00,.6980E 00,.7103E 00,.7212E 00,.7403E 00/      QY2  325
 DATA BE/ .7566E 00,.7708E 00,.7838E 00,.7957E 00,.8066E 00,.8265E QY2  330
> 00, .8438E 00,.8593E 00,.8733E 00,.8889E 00,.9075E 00,.9173E 00, QY2  335
> .9332E 00,.9617E 00,.2670E 00,.2811E 00,.2923E 00,.3106E 00,      QY2  340
> .3254E 00,.3382E 00,.3496E 00,.3599E 00,.3695E 00,.3785E 00,      QY2  345
> .3869E 00,.4062E 00,.4225E 00,.4399E 00,.4551E 00,.4831E 00,      QY2  350
> .5091E 00,.5333E 00,.5568E 00,.6012E 00,.6437E 00,.6817E 00,      QY2  355
> .7185E 00,.7525E 00,.7844E 00,.8389E 00,.8837E 00,.9185E 00,      QY2  360
> .9445E 00,.9632E 00,.9851E 00,.9910E 00,.9970E 00,.9998E 00,      QY2  365
> .1454E 00,.1597E 00,.1714E 00,.1905E 00,.2062E 00,.2200E 00,      QY2  370
> .2324E 00,.2439E 00,.2552E 00,.2647E 00,.2744E 00,.2970E 00,      QY2  375
> .3181E 00,.3383E 00,.3579E 00,.3958E 00,.4330E 00,.4700E 00,      QY2  380
> .5069E 00,.5794E 00,.6489E 00,.7132E 00,.7713E 00,.8220E 00,      QY2  385
> .8646E 00,.9267E 00,.9635E 00,.9831E 00,.9930E 00,.9971E 00,      QY2  390
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> .4660E-01,.5883E-01,.7010E-01,.8089E-01,.9144E-01,.1019E 00,      QY2  400
> .1124E 00,.1229E 00,.1337E 00,.1615E 00,.1913E 00,.2232E 00,      QY2  405
> .2573E 00,.3320E 00,.4135E 00,.4982E 00,.5821E 00,.7337E 00,      QY2  410
> .8479E 00,.9214E 00,.9629E 00,.9836E 00,.9935E 00,.9988E 00,      QY2  415
> .9999E 00,.1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01/      QY2  420
 DATA BF/ .1000E 01,.1000E 01,.5537E-03,.1017E-02,.1627E-02,.3389E-QY2  425
> 02, .6080E-02,.1002E-01,.1563E-01,.2338E-01,.3384E-01,.4774E-01, QY2  430
> .6508E-01,.1285E 00,.2219E 00,.3402E 00,.4721E 00,.7158E 00,      QY2  435
> .8758E 00,.9541E 00,.9853E 00,.9984E 00,.9999E 00,.1000E 01,      QY2  440
> .1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,      QY2  445
> .1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,      QY2  450
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> .7907E 00,.7956E 00,.7999E 00,.8037E 00,.8071E 00,.8143E 00,      QY2  460
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> .8531E 00,.8607E 00,.8672E 00,.8725E 00,.8771E 00,.8813E 00,      QY2  470
> .8850E 00,.8916E 00,.8970E 00,.9018E 00,.9060E 00,.9098E 00,      QY2  475
> .9166E 00,.9194E 00,.9246E 00,.9352E 00,.6215E 00,.6386E 00,      QY2  480
> .6506E 00,.6684E 00,.6813E 00,.6916E 00,.7000E 00,.7034E 00,      QY2  485
> .7135E 00,.7192E 00,.7242E 00,.7351E 00,.7441E 00,.7517E 00,      QY2  490
> .7584E 00,.7698E 00,.7792E 00,.7872E 00,.7943E 00,.8062E 00,      QY2  495
> .8160E 00,.8244E 00,.8318E 00,.8383E 00,.8442E 00,.8545E 00,      QY2  500
> .8632E 00,.8709E 00,.8777E 00,.8838E 00,.8944E 00,.8991E 00,      QY2  505
> .9075E 00,.9243E 00,.4667E 00,.4849E 00,.4984E 00,.5185E 00,      QY2  510
> .5297E 00,.5456E 00,.5558E 00,.5647E 00,.5690E 00,.5795E 00/      QY2  515
 DATA BG/ .5862E 00,.5999E 00,.6116E 00,.6219E 00,.6308E 00,.6446E QY2  520
> 00, .6597E 00,.6713E 00,.6817E 00,.6999E 00,.7154E 00,.7290E 00, QY2  525
> .7415E 00,.7529E 00,.7767E 00,.7828E 00,.7998E 00,.8153E 00,      QY2  530
> .8294E 00,.8417E 00,.8651E 00,.8752E 00,.8939E 00,.9284E 00,      QY2  535
> .2202E 00,.2318E 00,.2410E 00,.2561E 00,.2683E 00,.2789E 00,      QY2  540
> .2883E 00,.2969E 00,.3048E 00,.3122E 00,.3192E 00,.3353E 00,      QY2  545
> .3488E 00,.3634E 00,.3761E 00,.3999E 00,.4222E 00,.4431E 00,      QY2  550
> .4637E 00,.5033E 00,.5422E 00,.5783E 00,.6143E 00,.6489E 00,      QY2  555
> .6820E 00,.7447E 00,.7983E 00,.8447E 00,.8833E 00,.9140E 00,      QY2  560
> .9563E 00,.9699E 00,.9863E 00,.9984E 00,.1055E 00,.1158E 00,      QY2  565
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     > .1243E 00,.1382E 00,.1496E 00,.1597E 00,.1688E 00,.1772E 00,      QY2  570
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     > .2626E 00,.2922E 00,.3221E 00,.3526E 00,.3839E 00,.4484E 00,      QY2  580
     > .5145E 00,.5819E 00,.6441E 00,.7043E 00,.7591E 00,.8489E 00,      QY2  585
     > .9119E 00,.9520E 00,.9756E 00,.9882E 00,.9977E 00,.9985E 00,      QY2  590
     > .9997E 00,.1000E 01,.1705E-01,.2104E-01,.2461E-01,.3111E-01,      QY2  595
     > .3713E-01,.4294E-01,.4865E-01,.5437E-01,.6016E-01,.6608E-01,      QY2  600
     > .7216E-01,.8827E-01,.1061E 00,.1258E 00,.1479E 00,.1992E 00,      QY2  605
     > .2602E 00,.3299E 00,.4059E 00,.5647E 00,.7102E 00,.8240E 00/      QY2  610
      DATA BH/ .9016E 00,.9489E 00,.9753E 00,.9951E 00,.9987E 00,.9998E QY2  615
     > 00, .1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01, QY2  620
     > .1117E-03,.2060E-03,.3318E-03,.7035E-03,.1294E-02,.2200E-02,      QY2  625
     > .3561E-02,.5560E-02,.8440E-02,.1255E-01,.1809E-01,.4159E-01,      QY2  630
     > .8444E-01,.1521E 00,.2460E 00,.4827E 00,.7077E 00,.8603E 00,      QY2  635
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     > .1000E 01,.1000E 01,.1000E 01,.1000E 01,.7105E 00,.7221E 00,      QY2  650
     > .7294E 00,.7414E 00,.7500E 00,.7567E 00,.7623E 00,.7641E 00,      QY2  655
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     > .7331E 00,.7366E 00,.7472E 00,.7584E 00,.7677E 00,.7714E 00,      QY2  695
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     > 01, .6657E-01,.1385E 00,.2527E 00,.4015E 00,.5617E 00,.7066E 00, QY2  810
     > .8197E 00,.9452E 00,.9864E 00,.9972E 00,.9996E 00,.9999E 00,      QY2  815
     > .1000E 01,.1000E 01,.1000E 01,.1000E 01,.9405E-07,.1762E-06,      QY2  820
     > .2900E-06,.6541E-06,.1310E-05,.2483E-05,.4578E-05,.8309E-05,      QY2  825
     > .1494E-04,.2677E-04,.4723E-04,.1902E-03,.7132E-03,.2424E-02,      QY2  830
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     > .9854E 00,.9983E 00,.9999E 00,.1000E 01,.1000E 01,.1000E 01,      QY2  840
     > .1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,      QY2  845
     > .1000E 01,.1000E 01,.6847E 00,.6959E 00,.7021E 00,.7136E 00,      QY2  850
     > .7219E 00,.7283E 00,.7337E 00,.7359E 00,.7422E 00,.7458E 00,      QY2  855
```

```
> .7488E 00,.7556E 00,.7611E 00,.7659E 00,.7698E 00,.7769E 00,     QY2  860
> .7824E 00,.7874E 00,.7915E 00,.7986E 00,.8045E 00,.8096E 00,     QY2  865
> .8138E 00,.8177E 00,.8211E 00,.8271E 00,.8324E 00,.8367E 00,     QY2  870
> .8407E 00,.8442E 00,.8504E 00,.8531E 00,.8580E 00,.8680E 00,     QY2  875
> .5533E 00,.5684E 00,.5795E 00,.5933E 00,.6048E 00,.6138E 00,     QY2  880
> .6213E 00,.6278E 00,.6334E 00,.6384E 00,.6429E 00,.6525E 00,     QY2  885
> .6605E 00,.6673E 00,.6732E 00,.6832E 00,.6915E 00,.6987E 00,     QY2  890
> .7049E 00,.7155E 00,.7242E 00,.7317E 00,.7382E 00,.7440E 00/     QY2  895
 DATA BK/ .7493E 00,.7585E 00,.7663E 00,.7731E 00,.7792E 00,.7847E QY2  900
> 00, .7943E 00,.7985E 00,.8062E 00,.8217E 00,.2979E 00,.3095E 00, QY2  905
> .3181E 00,.3310E 00,.3381E 00,.3482E 00,.3548E 00,.3604E 00,     QY2  910
> .3631E 00,.3699E 00,.3741E 00,.3829E 00,.3904E 00,.3969E 00,     QY2  915
> .4027E 00,.4115E 00,.4212E 00,.4287E 00,.4353E 00,.4471E 00,     QY2  920
> .4572E 00,.4661E 00,.4743E 00,.4819E 00,.4975E 00,.5022E 00,     QY2  925
> .5141E 00,.5251E 00,.5355E 00,.5448E 00,.5634E 00,.5719E 00,     QY2  930
> .5884E 00,.6248E 00,.4172E-01,.4391E-01,.4567E-01,.4852E-01,     QY2  935
> .5085E-01,.5286E-01,.5465E-01,.5629E-01,.5781E-01,.5923E-01,     QY2  940
> .6058E-01,.6369E-01,.6636E-01,.6923E-01,.7177E-01,.7661E-01,     QY2  945
> .8127E-01,.8579E-01,.9037E-01,.9965E-01,.1094E 00,.1193E 00,     QY2  950
> .1299E 00,.1410E 00,.1527E 00,.1783E 00,.2057E 00,.2356E 00,     QY2  955
> .2675E 00,.3011E 00,.3722E 00,.4091E 00,.4835E 00,.6592E 00,     QY2  960
> .1276E-02,.1402E-02,.1506E-02,.1676E-02,.1818E-02,.1946E-02,     QY2  965
> .2062E-02,.2172E-02,.2283E-02,.2380E-02,.2482E-02,.2732E-02,     QY2  970
> .2987E-02,.3253E-02,.3539E-02,.4178E-02,.4948E-02,.5884E-02,     QY2  975
> .7036E-02,.1020E-01,.1500E-01,.2226E-01,.3285E-01,.4840E-01,     QY2  980
> .6984E-01,.1372E 00,.2418E 00,.3787E 00,.5296E 00,.6713E 00,     QY2  985
> .8716E 00,.9266E 00,.9798E 00,.9995E 00,.2537E-05,.3139E-05/     QY2  990
 DATA BL/ .3686E-05,.4710E-05,.5708E-05,.6729E-05,.7808E-05,.8974E-QY2  995
> 05, .1025E-04,.1168E-04,.1328E-04,.1828E-04,.2532E-04,.3544E-04, QY2 1000
> .5018E-04,.1039E-03,.2224E-03,.4847E-03,.1058E-02,.4772E-02,     QY2 1005
> .1847E-01,.5763E-01,.1418E 00,.2781E 00,.4481E 00,.7576E 00,     QY2 1010
> .9219E 00,.9801E 00,.9957E 00,.9991E 00,.1000E 01,.1000E 01,     QY2 1015
> .1000E 01,.1000E 01,.2950E-13,.5676E-13,.9703E-13,.2437E-12,     QY2 1020
> .5664E-12,.1298E-11,.3005E-11,.7108E-11,.1725E-10,.4305E-10,     QY2 1025
> .1090E-09,.1209E-08,.1404E-07,.1584E-06,.1625E-05,.1032E-03,     QY2 1030
> .2736E-02,.2892E-01,.1371E 00,.6007E 00,.9042E 00,.9849E 00,     QY2 1035
> .9978E 00,.9998E 00,.1000E 01,.1000E 01,.1000E 01,.1000E 01,     QY2 1040
> .1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,     QY2 1045
> .6645E 00,.6754E 00,.6814E 00,.6925E 00,.7006E 00,.7068E 00,     QY2 1050
> .7120E 00,.7141E 00,.7203E 00,.7238E 00,.7267E 00,.7333E 00,     QY2 1055
> .7386E 00,.7432E 00,.7470E 00,.7539E 00,.7593E 00,.7641E 00,     QY2 1060
> .7681E 00,.7750E 00,.7807E 00,.7857E 00,.7897E 00,.7935E 00,     QY2 1065
> .7968E 00,.8027E 00,.8078E 00,.8119E 00,.8158E 00,.8193E 00,     QY2 1070
> .8252E 00,.8279E 00,.8327E 00,.8423E 00,.5379E 00,.5526E 00,     QY2 1075
> .5608E 00,.5762E 00,.5873E 00,.5961E 00,.6034E 00,.6096E 00,     QY2 1080
> .6151E 00,.6200E 00,.6243E 00,.6336E 00,.6414E 00,.6480E 00/     QY2 1085
 DATA BM/ .6538E 00,.6635E 00,.6716E 00,.6784E 00,.6845E 00,.6947E QY2 1090
> 00, .7032E 00,.7105E 00,.7169E 00,.7225E 00,.7276E 00,.7365E 00, QY2 1095
> .7441E 00,.7507E 00,.7566E 00,.7620E 00,.7713E 00,.7754E 00,     QY2 1100
> .7828E 00,.7979E 00,.2533E 00,.2632E 00,.2705E 00,.2814E 00,     QY2 1105
> .2875E 00,.2962E 00,.3017E 00,.3065E 00,.3088E 00,.3146E 00,     QY2 1110
> .3182E 00,.3256E 00,.3320E 00,.3376E 00,.3424E 00,.3499E 00,     QY2 1115
> .3582E 00,.3646E 00,.3702E 00,.3803E 00,.3888E 00,.3965E 00,     QY2 1120
> .4035E 00,.4100E 00,.4233E 00,.4273E 00,.4375E 00,.4470E 00,     QY2 1125
> .4559E 00,.4640E 00,.4801E 00,.4876E 00,.5021E 00,.5345E 00,     QY2 1130
> .2252E-01,.2370E-01,.2465E-01,.2619E-01,.2745E-01,.2854E-01,     QY2 1135
> .2950E-01,.3039E-01,.3121E-01,.3198E-01,.3271E-01,.3439E-01,     QY2 1140
> .3584E-01,.3739E-01,.3878E-01,.4141E-01,.4395E-01,.4643E-01,     QY2 1145
> .4895E-01,.5407E-01,.5950E-01,.6503E-01,.7104E-01,.7740E-01,
> .8414E-01,.9908E-01,.1155E 00,.1338E 00,.1539E 00,.1866E 00,
> .2239E 00,.2502E 00,.3064E 00,.4595E 00,.1152E-03,.1266E-03,
> .1360E-03,.1515E-03,.1645E-03,.1762E-03,.1870E-03,.1973E-03,
> .2077E-03,.2170E-03,.2268E-03,.2513E-03,.2771E-03,.3047E-03,
> .3352E-03,.4064E-03,.4970E-03,.6136E-03,.7655E-03,.1225E-02,
> .2019E-02,.3404E-02,.5762E-02,.9766E-02,.1636E-01,.4290E-01/
 DATA BN/ .9892E-01,.1957E 00,.3315E 00,.4878E 00,.7641E 00,.8557E
> 00, .9550E 00,.9986E 00,.2082E-07,.2579E-07,.3034E-07,.3895E-07,
> .4752E-07,.5651E-07,.6627E-07,.7711E-07,.8938E-07,.1035E-06,
> .1198E-06,.1739E-06,.2568E-06,.3873E-06,.5966E-06,.1504E-05,
> .4044E-05,.1136E-04,.3259E-04,.2618E-03,.1804E-02,.9618E-02,
> .3775E-01,.1086E 00,.2360E 00,.5815E 00,.8398E 00,.9532E 00,
> .9887E 00,.9971E 00,.9999E 00,.1000E 01,.1000E 01,.1000E 01,
> .1773E-18,.3477E-18,.6103E-18,.1653E-17,.4267E-17,.1117E-16,
> .3040E-16,.8674E-16,.2603E-15,.8231E-15,.2698E-14,.6198E-13,
> .1639E-11,.4478E-10,.1145E-08,.4389E-06,.5783E-04,.2241E-02,
> .2790E-01,.3603E 00,.7961E 00,.9608E 00,.9944E 00,.9992E 00,
> .9999E 00,.1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,
> .1000E 01,.1000E 01,.1000E 01,.1000E 01,.5953E 00,.6050E 00,
> .6104E 00,.6204E 00,.6276E 00,.6332E 00,.6379E 00,.6398E 00,
> .6453E 00,.6484E 00,.6510E 00,.6569E 00,.6617E 00,.6658E 00,
> .6692E 00,.6754E 00,.6802E 00,.6845E 00,.6881E 00,.6943E 00,
> .6994E 00,.7038E 00,.7074E 00,.7108E 00,.7138E 00,.7190E 00,
> .7236E 00,.7274E 00,.7308E 00,.7339E 00,.7393E 00,.7417E 00,
> .7460E 00,.7546E 00,.4818E 00,.4950E 00,.5024E 00,.5161E 00/
 DATA BO/ .5261E 00,.5340E 00,.5405E 00,.5461E 00,.5510E 00,.5554E
> 00, .5593E 00,.5676E 00,.5746E 00,.5805E 00,.5857E 00,.5944E 00,
> .6017E 00,.6078E 00,.6132E 00,.6224E 00,.6300E 00,.6365E 00,
> .6422E 00,.6472E 00,.6518E 00,.6598E 00,.6666E 00,.6725E 00,
> .6778E 00,.6826E 00,.6909E 00,.6946E 00,.7013E 00,.7148E 00,
> .1665E 00,.1730E 00,.1778E 00,.1850E 00,.1890E 00,.1947E 00,
> .1983E 00,.2015E 00,.2030E 00,.2068E 00,.2092E 00,.2140E 00,
> .2182E 00,.2219E 00,.2251E 00,.2300E 00,.2355E 00,.2397E 00,
> .2434E 00,.2500E 00,.2556E 00,.2607E 00,.2653E 00,.2696E 00,
> .2784E 00,.2811E 00,.2879E 00,.2942E 00,.3003E 00,.3058E 00,
> .3168E 00,.3216E 00,.3315E 00,.3541E 00,.4445E-02,.4679E-02,
> .4866E-02,.5170E-02,.5418E-02,.5633E-02,.5824E-02,.5999E-02,
> .6162E-02,.6314E-02,.6458E-02,.6792E-02,.7078E-02,.7388E-02,
> .7663E-02,.8189E-02,.8693E-02,.9191E-02,.9700E-02,.1077E-01,
> .1186E-01,.1301E-01,.1427E-01,.1562E-01,.1708E-01,.2036E-01,
> .2409E-01,.2837E-01,.3324E-01,.3873E-01,.5173E-01,.5932E-01,
> .7684E-01,.1353E 00,.3120E-07,.3430E-07,.3686E-07,.4112E-07,
> .4477E-07,.4811E-07,.5126E-07,.5433E-07,.5752E-07,.6046E-07,
> .6362E-07,.7194E-07,.8128E-07,.9203E-07,.1046E-06,.1374E-06/
 DATA BP/ .1849E-06,.2553E-06,.3616E-06,.7781E-06,.1815E-05,.4514E-
> 05, .1165E-04,.3083E-04,.8184E-04,.5435E-03,.3051E-02,.1348E-01,
> .4544E-01,.1173E 00,.3945E 00,.5580E 00,.8127E 00,.9910E 00,
> .1555E-14,.1933E-14,.2286E-14,.2977E-14,.3706E-14,.4522E-14,
> .5473E-14,.6609E-14,.7995E-14,.9711E-14,.1186E-13,.2018E-13,
> .3607E-13,.6798E-13,.1349E-12,.6143E-12,.3299E-11,.2013E-10,
> .1339E-09,.6559E-08,.2887E-06,.9102E-05,.1779E-03,.2027E-02,
> .1354E-01,.1542E 00,.4907E 00,.7884E 00,.9324E 00,.9820E 00,
> .9988E 00,.9998E 00,.1000E 01,.1000E 01,.2217E-33,.2222E-33,
> .2231E-33,.2266E-33,.2369E-33,.2738E-33,.4361E-33,.1266E-32,
> .6106E-32,.3799E-31,.2696E-30,.5640E-28,.1856E-25,.7880E-23,
> .3573E-20,.4526E-15,.1309E-10,.4985E-07,.2293E-04,.2535E-01,
> .3578E 00,.7910E 00,.9570E 00,.9932E 00,.9988E 00,.1000E 01,
     > .1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,      QY2 1440
     > .1000E 01,.1000E 01/                                              QY2 1445
      DO 30 I=1,34                                                       QY2 1450
         DO 20 K=1,7                                                     QY2 1455
            DO 10 L=14,20                                                QY2 1460
10             REFA(I,K,L)=SEFA(I,K,L)                                   QY2 1465
20          CONTINUE                                                     QY2 1470
30       CONTINUE                                                        QY2 1475
      RETURN                                                             QY2 1480
      END                                                                QY2 1485
```

```
 SUBROUTINE QY3
 COMMON /QCOM/ REFA(34,7,20)
 DIMENSION SEFA(34,7,20)
 DIMENSION CA(44),AP(114),AQ(114),AR(114),AS(114),AT(114),AU(114),
> AV(114),AW(114),AX(114),AY(114),AZ(114),BA(114),BB(16)
 EQUIVALENCE (SEFA( 1,1, 8),CA(1)), (SEFA(11,2, 8),AP(1)),(SEFA(23,
> 5, 8),AQ(1)),(SEFA( 1,2, 9),AR(1)),(SEFA(13,5, 9),AS(1)),
> (SEFA(25,1,10),AT(1)),(SEFA( 3,5,10),AU(1)),(SEFA(15,1,11),AV(1))
> ,(SEFA(27,4,11),AW(1)),(SEFA( 5,1,12),AX(1)),(SEFA(17,4,12),AY(1)
> ),(SEFA(29,7,12),AZ(1)),(SEFA( 7,4,13),BA(1)),(SEFA(19,7,13),
> BB(1))
 DATA CA/ .8298E 00,.8434E 00, .8531E 00,.8672E 00,.8771E 00,
> .8850E 00,.8916E 00,.8970E 00, .9018E 00,.9060E 00,.9098E 00,
> .9180E 00,.9246E 00,.9303E 00, .9352E 00,.9436E 00,.9501E 00,
> .9556E 00,.9617E 00,.9683E 00, .9744E 00,.9792E 00,.9831E 00,
> .9863E 00,.9882E 00,.9928E 00, .9954E 00,.9972E 00,.9983E 00,
> .9990E 00,.9991E 00,.9994E 00, .9998E 00,.1000E 01,.7585E 00,
> .7792E 00,.7943E 00,.8160E 00, .8318E 00,.8442E 00,.8545E 00,
> .8632E 00,.8709E 00,.8777E 00/
 DATA AP/ .8838E 00,.8952E 00,.9075E 00,.9166E 00,.9243E 00,.9391E
> 00, .9477E 00,.9561E 00,.9631E 00,.9739E 00,.9816E 00,.9871E 00,
> .9911E 00,.9940E 00,.9959E 00,.9982E 00,.9993E 00,.9992E 00,
> .9997E 00,.9999E 00,.1000E 01,.1000E 01,.1000E 01,.1000E 01,
> .6871E 00,.7139E 00,.7338E 00,.7634E 00,.7853E 00,.8030E 00,
> .8178E 00,.8306E 00,.8418E 00,.8518E 00,.8616E 00,.8804E 00,
> .8963E 00,.9120E 00,.9213E 00,.9401E 00,.9542E 00,.9652E 00,
> .9737E 00,.9853E 00,.9922E 00,.9959E 00,.9979E 00,.9990E 00,
> .9987E 00,.9997E 00,.1000E 01,.1000E 01,.1000E 01,.1000E 01,
> .1000E 01,.1000E 01,.1000E 01,.1000E 01,.5895E 00,.6204E 00,
> .6450E 00,.6846E 00,.7163E 00,.7432E 00,.7667E 00,.7875E 00,
> .8063E 00,.8232E 00,.8386E 00,.8717E 00,.8986E 00,.9202E 00,
> .9373E 00,.9631E 00,.9790E 00,.9886E 00,.9940E 00,.9985E 00,
> .9991E 00,.9998E 00,.1000E 01,.1000E 01,.1000E 01,.1000E 01,
> .1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,
> .1000E 01,.1000E 01,.4799E 00,.5268E 00,.5647E 00,.6257E 00,
> .6746E 00,.7160E 00,.7515E 00,.7825E 00,.8098E 00,.8339E 00,
> .8553E 00,.8987E 00,.9304E 00,.9532E 00,.9692E 00,.9876E 00,
> .9955E 00,.9983E 00,.9992E 00,.9999E 00,.1000E 01,.1000E 01/
 DATA AQ/ .1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E
> 01, .1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,
> .3226E 00,.3959E 00,.4595E 00,.5680E 00,.6573E 00,.7318E 00,
> .7931E 00,.8424E 00,.8820E 00,.9129E 00,.9370E 00,.9737E 00,
> .9899E 00,.9965E 00,.9987E 00,.9996E 00,.1000E 01,.1000E 01,
> .1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,
> .1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,
> .1000E 01,.1000E 01,.1000E 01,.1000E 01,.1865E 00,.3136E 00,
> .4461E 00,.6825E 00,.8441E 00,.9331E 00,.9746E 00,.9914E 00,
> .9973E 00,.9991E 00,.9991E 00,.1000E 01,.1000E 01,.1000E 01,
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> .1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,
> .1000E 01,.1000E 01,.8211E 00,.8317E 00,.8443E 00,.8551E 00,
> .8680E 00,.8758E 00,.8792E 00,.8876E 00,.8924E 00,.8966E 00,
> .9004E 00,.9060E 00,.9151E 00,.9207E 00,.9256E 00,.9337E 00,
> .9408E 00,.9461E 00,.9510E 00,.9590E 00,.9655E 00,.9708E 00,
> .9752E 00,.9789E 00,.9820E 00,.9868E 00,.9906E 00,.9933E 00,
      SUBROUTINE CHIQ
      COMMON /OCOM/ NAMNUC(36),WORD,NNUCS,ANLAM(36),RR,SQSD, ACON(36,20,
     >  20),GCON(36,20,20),LIPO,NOMM(36,11),NRMM(36,11), ORMODI(36,12,8)
     > , VD(36),VDCOEF(20,20),NOL,NOU,NRL,NRU
      REAL*8 NAMNUC,WORD
      COMMON /PCOM/ REL(6,36),IDIST(20),NUMST
      COMMON /TCOM/ KIQ(36,20,20)
      DIMENSION REGL(35)
      REAL KIQ
      DO 30 I=1,NNUCS
         DO 20 NO=1,16
            DO 10 NR=1,20
   10          KIQ(I,NO,NR)=0
   20       CONTINUE
   30    CONTINUE
      DO 50 I=1,NNUCS
         REGL(I)=0
         DO 40 J=1,NUMST
   40       REGL(I)=REGL(I)+REL(J,I)
   50    CONTINUE
      DO 90 I=1,NNUCS
         DO 80 NO=NOL,NOU
            DO 60 NR=NRL,NRU
               IF (REGL(I).EQ.0) GO TO 70
   60          KIQ(I,NO,NR)=(ACON(I,NO,NR)/REGL(I))*1.E6
            GO TO 80
   70       KIQ(I,NO,NR)=0.
   80       CONTINUE
   90    CONTINUE
      DO 130 I=1,NNUCS
         WRITE(51,9000) NAMNUC(I)
         WRITE(51,9001)
         WRITE(51,9002)
         WRITE(51,9003)
         WRITE(51,9001)
         WRITE(51,9004)
         WRITE(51,9005)
         NO=1
         DO 100 NR=NRL,NRU
  100       WRITE(51,9007)IDIST(NR),KIQ(I,NO,NR),KIQ(I,NO+1,NR),KIQ(I,
     >       NO+2,NR),KIQ(I,NO+3,NR),KIQ(I,NO+4,NR),KIQ(I,NO+5,NR),
     >       KIQ(I,NO+6,NR), KIQ(I,NO+7,NR)
         ISP= (22-2*(NRU/2))/2
         DO 110 IG=1,ISP
  110       WRITE(51,9001)
         WRITE(51,9006)
         WRITE(51,9005)
         NO=9
         DO 120 NR=NRL,NRU
  120       WRITE(51,9007)IDIST(NR),KIQ(I,NO,NR),KIQ(I,NO+1,NR),KIQ(I,
     >       NO+2,NR),KIQ(I,NO+3,NR),KIQ(I,NO+4,NR),KIQ(I,NO+5,NR),
     >       KIQ(I,NO+6,NR), KIQ(I,NO+7,NR)
  130    CONTINUE
      RETURN
 9000 FORMAT('1',T25,'GROUND-LEVEL CHI/Q VALUES FOR ',A8,
     > 'AT VARIOUS DISTANCES IN EACH COMPASS DIRECTION')
 DATA AU/ .4898E 00,.5434E 00,.5870E 00,.6243E 00,.6570E 00,.6864E QY3  570
> 00, .7092E 00,.7373E 00,.7594E 00,.8073E 00,.8465E 00,.8788E 00, QY3  575
> .9048E 00,.9431E 00,.9673E 00,.9820E 00,.9905E 00,.9977E 00,      QY3  580
> .9992E 00,.9997E 00,.9999E 00,.1000E 01,.1000E 01,.1000E 01,      QY3  585
> .1000E 01,.1000F 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,      QY3  590
> .1000E 01,.1000E 01,.2448E 00,.3011E 00,.3507E C0,.4374E 00,      QY3  595
> .5127E 00,.5794E 00,.6387E 00,.6915E 00,.7383E 00,.7795E 00,      QY3  600
> .8147E 00,.8848E 00,.9315E 00,.9610E 00,.9788E 00,.9944E 00,      QY3  605
> .9985E 00,.9990E 00,.9998E 00,.1000E 01,.1000E 01,.1000E 01,      QY3  610
> .1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,      QY3  615
> .1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,      QY3  620
> .9490E-01,.1655E 00,.2472E 00,.4257E 00,.5953E 00,.7377E 00,      QY3  625
> .8409E 00,.9094E 00,.9514E 00,.9753E 00,.9881E 00,.9984E 00,      QY3  630
> .9993E 00,.9999E 00,.1000E 01,.1000E 01,.1000E 01,.1000E 01,      QY3  635
> .1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000F 01,      QY3  640
> .1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,      QY3  645
> .1000E 01,.1000E 01,.1000E 01,.1000E 01,.8071E 00,.8204E 00,      QY3  650
> .8298E 00,.8435E 00,.8531E 00,.8607E 00,.8672E 00,.8725E 00,      QY3  655
> .8771E 00,.8781E 00,.8850E 00,.8930E 00,.8995E 00,.9050E 00/      QY3  660
 DATA AV/ .9098E 00,.9180E 00,.9246E 00,.9303E 00,.9352E 00,.9436E QY3  665
> 00, .9501E 00,.9556E 00,.9617E 00,.9647E 00,.9683E 00,.9744E 00, QY3  670
> .9792E 00,.9831E 00,.9863E 00,.9882E 00,.9928E 00,.9943E 00,      QY3  675
> .9964E 00,.9990E 00,.7242E 00,.7441E 00,.7584E 00,.7792E 00,      QY3  680
> .7943E 00,.8062E 00,.8160E 00,.8244E 00,.8318E 00,.8383E 00,      QY3  685
> .8442E 00,.8568E 00,.8673E 00,.8761E 00,.8838E 00,.8952E 00,      QY3  690
> .9075E 00,.9166E 00,.9243E 00,.9391E 00,.9477E 00,.9561E 00,      QY3  695
> .9631E 00,.9689E 00,.9739E 00,.9816E 00,.9871E 00,.9911E 00,      QY3  700
> .9940E 00,.9959E 00,.9982E 00,.9989E 00,.9988E 00,.9999E 00,      QY3  705
> .6376E 00,.6624E 00,.6809E 00,.7084E 00,.7236E 00,.7453E 00,      QY3  710
> .7592E 00,.7712E 00,.7770E 00,.7913E 00,.8003E 00,.8186E 00,      QY3  715
> .8343E 00,.8477E 00,.8597E 00,.8770E 00,.8960E 00,.9098E 00,      QY3  720
> .9216E 00,.9408E 00,.9552E 00,.9662E 00,.9748E 00,.9813E 00,      QY3  725
> .9862E 00,.9930E 00,.9964E 00,.9982E 00,.9992E 00,.9990E 00,      QY3  730
> .9998E 00,.9999E 00,.1000E 01,.1000E 01,.5086E 00,.5353E 00,      QY3  735
> .5567E 00,.5911E 00,.6190E 00,.6429E 00,.6639E 00,.6829E 00,      QY3  740
> .7002E 00,.7162E 00,.7310E 00,.7641E 00,.7904E 00,.8178E 00,      QY3  745
> .8398E 00,.8768E 00,.9062E 00,.9288E 00,.9471E 00,.9718E 00,      QY3  750
> .9858E 00,.9932E 00,.9970E 00,.9986E 00,.9991E 00,.9997E 00/      QY3  755
 DATA AW/ .1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E QY3  760
> 01, .1000E 01,.1000E 01,.3873E 00,.4252E 00,.4561E 00,.5062E 00, QY3  765
> .5471E 00,.5823E 00,.6133E 00,.6412E 00,.6683E 00,.6901E 00,      QY3  770
> .7120E 00,.7596E 00,.7997E 00,.8338E 00,.8630E 00,.9079E 00,      QY3  775
> .9398E 00,.9618E 00,.9764E 00,.9918E 00,.9975E 00,.9992E 00,      QY3  780
> .9993E 00,.9998E 00,.1000E 01,.1000E 01,.1000E 01,.1000E 01,      QY3  785
> .1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,      QY3  790
> .2134E 00,.2627E 00,.3062E 00,.3830E 00,.4505E 00,.5112E 00,      QY3  795
> .5664E 00,.6167E 00,.6625E 00,.7040E 00,.7417E 00,.8196E 00,      QY3  800
> .8777E 00,.9196E 00,.9487E 00,.9810E 00,.9936E 00,.9981E 00,      QY3  805
> .9994E 00,.9999E 00,.1000E 01,.1000E 01,.1000E 01,.1000E 01,      QY3  810
> .1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,      QY3  815
> .1000E 01,.1000E 01,.1000E 01,.1000E 01,.6700E-01,.1182E 00,      QY3  820
> .1791E 00,.3204E 00,.4701E 00,.6098E 00,.7277E 00,.8190E 00,      QY3  825
> .8851E 00,.9300E 00,.9590E 00,.9908E 00,.9983E 00,.9989E 00,      QY3  830
> .9998E 00,.1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,      QY3  835
> .1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,      QY3  840
> .1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,      QY3  845
> .1000E 01,.1000E 01,.7941E 00,.8071E 00,.8164E 00,.8298E 00/      QY3  850
 DATA AX/ .8394E 00,.8469E 00,.8531E 00,.8556E 00,.8630E 00,.8672E QY3  855
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> 00, .8707E 00,.8786E 00,.8850E 00,.8906E 00,.8952E 00,.9032E 00, QY3  860
> .9098E 00,.9157E 00,.9203E 00,.9285E 00,.9352E 00,.9412E 00,      QY3  865
> .9458E 00,.9501E 00,.9529E 00,.9617E 00,.9659E 00,.9705E 00,      QY3  870
> .9744E 00,.9777E 00,.9831E 00,.9854E 00,.9882E 00,.9947E 00,      QY3  875
> .7050E 00,.7242E 00,.7382E 00,.7584E 00,.7731E 00,.7847E 00,      QY3  880
> .7943E 00,.8025E 00,.8096E 00,.8160E 00,.8217E 00,.8340E 00,      QY3  885
> .8442E 00,.8529E 00,.8604E 00,.8733E 00,.8838E 00,.8928E 00,      QY3  890
> .9006E 00,.9137E 00,.9243E 00,.9333E 00,.9409E 00,.9477E 00,      QY3  895
> .9535E 00,.9631E 00,.9707E 00,.9768E 00,.9816E 00,.9855E 00,      QY3  900
> .9911E 00,.9931E 00,.9959E 00,.9990E 00,.6087E 00,.6323E 00,      QY3  905
> .6500E 00,.6763E 00,.6908E 00,.7115E 00,.7248E 00,.7363E 00,      QY3  910
> .7419E 00,.7556E 00,.7642E 00,.7819E 00,.7970E 00,.8101E 00,      QY3  915
> .8217E 00,.8389E 00,.8578E 00,.8719E 00,.8846E 00,.9053E 00,      QY3  920
> .9217E 00,.9350E 00,.9463E 00,.9556E 00,.9635E 00,.9757E 00,      QY3  925
> .9839E 00,.9897E 00,.9935E 00,.9954E 00,.9985E 00,.9992E 00,      QY3  930
> .9998E 00,.1000E 01,.4609E 00,.4851E 00,.5045E 00,.5358E 00,      QY3  935
> .5611E 00,.5829E 00,.6022E 00,.6197E 00,.6357E 00,.6505E 00,      QY3  940
> .6643E 00,.6956E 00,.7209E 00,.7476E 00,.7698E 00,.8086E 00/      QY3  945
 DATA AY/ .8417E 00,.8686E 00,.8920E 00,.9283E 00,.9536E 00,.9709E QY3  950
> 00, .9823E 00,.9894E 00,.9937E 00,.9981E 00,.9995E 00,.9999E 00, QY3  955
> .1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,      QY3  960
> .3359E 00,.3688E 00,.3957E 00,.4394E 00,.4751E 00,.5061E 00,      QY3  965
> .5336E 00,.5586E 00,.5829E 00,.6029E 00,.6229E 00,.6678E 00,      QY3  970
> .7071E 00,.7418E 00,.7731E 00,.8259E 00,.8678E 00,.9011E 00,      QY3  975
> .9272E 00,.9633E 00,.9828E 00,.9919E 00,.9962E 00,.9986E 00,      QY3  980
> .9995E 00,.1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,      QY3  985
> .1000E 01,.1000E 01,.1000E 01,.1000E 01,.1628E 00,.2005E 00,      QY3  990
> .2340E 00,.2936E 00,.3469E 00,.3958E 00,.4414E 00,.4842E 00,      QY3  995
> .5245E 00,.5625E 00,.5984E 00,.6790E 00,.7479E 00,.8050E 00,      QY3 1000
> .8525E 00,.9203E 00,.9601E 00,.9816E 00,.9921E 00,.9985E 00,      QY3 1005
> .9998E 00,.1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,      QY3 1010
> .1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,      QY3 1015
> .1000E 01,.1000E 01,.3335E-01,.5966E-01,.9211E-01,.1735E 00,      QY3 1020
> .2716E 00,.3792E 00,.4885E 00,.5918E 00,.6846E 00,.7639E 00,      QY3 1025
> .8284E 00,.9314E 00,.9764E 00,.9921E 00,.9975E 00,.9999E 00,      QY3 1030
> .1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,      QY3 1035
> .1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01/      QY3 1040
 DATA AZ/ .1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E QY3 1045
> 01, .7850E 00,.7979E 00,.8071E 00,.8204E 00,.8298E 00,.8372E 00, QY3 1050
> .8435E 00,.8486E 00,.8531E 00,.8540E 00,.8607E 00,.8685E 00,      QY3 1055
> .8749E 00,.8803E 00,.8850E 00,.8930E 00,.8995E 00,.9050E 00,      QY3 1060
> .9098E 00,.9180E 00,.9246E 00,.9303E 00,.9352E 00,.9399E 00,      QY3 1065
> .9436E 00,.9501E 00,.9556E 00,.9617E 00,.9647E 00,.9683E 00,      QY3 1070
> .9744E 00,.9769E 00,.9813E 00,.9882E 00,.6916E 00,.7105E 00,      QY3 1075
> .7242E 00,.7440E 00,.7584E 00,.7698E 00,.7792E 00,.7872E 00,      QY3 1080
> .7943E 00,.8005E 00,.8062E 00,.8182E 00,.8283E 00,.8367E 00,      QY3 1085
> .8442E 00,.8568E 00,.8673E 00,.8761E 00,.8838E 00,.8952E 00,      QY3 1090
> .9075E 00,.9166E 00,.9243E 00,.9312E 00,.9391E 00,.9477E 00,      QY3 1095
> .9561E 00,.9631E 00,.9689E 00,.9739E 00,.9816E 00,.9846E 00,      QY3 1100
> .9893E 00,.9959E 00,.5876E 00,.6105E 00,.6276E 00,.6529E 00,      QY3 1105
> .6669E 00,.6870E 00,.6998E 00,.7109E 00,.7163E 00,.7295E 00,      QY3 1110
> .7379E 00,.7550E 00,.7697E 00,.7824E 00,.7937E 00,.8106E 00,      QY3 1115
> .8292E 00,.8431E 00,.8554E 00,.8764E 00,.8936E 00,.9081E 00,      QY3 1120
> .9207E 00,.9322E 00,.9414E 00,.9567E 00,.9679E 00,.9766E 00,      QY3 1125
> .9839E 00,.9883E 00,.9947E 00,.9965E 00,.9981E 00,.9998E 00,      QY3 1130
> .4262E 00,.4485E 00,.4665E 00,.4955E 00,.5190E 00,.5392E 00/      QY3 1135
 DATA BA/ .5572E 00,.5734E 00,.5884E 00,.6022E 00,.6152E 00,.6447E QY3 1140
> 00, .6689E 00,.6945E 00,.7160E 00,.7543E 00,.7876E 00,.8162E 00, QY3 1145
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     > .8421E 00,.8851E 00,.9171E 00,.9425E 00,.9609E 00,.9739E 00,
     > .9829E 00,.9933E 00,.9976E 00,.9989E 00,.9997E 00,.9999E 00,
     > .1000E 01,.1000E 01,.1000E 01,.1000E 01,.2994E 00,.3288E 00,
     > .3527E 00,.3918E 00,.4238E 00,.4516E 00,.4764E 00,.4990E 00,
     > .5211E 00,.5394E 00,.5578E 00,.5996E 00,.6368E 00,.6706E 00,
     > .7015E 00,.7556E 00,.8020E 00,.8416E 00,.8746E 00,.9251E 00,
     > .9579E 00,.9776E 00,.9884E 00,.9947E 00,.9975E 00,.9994E 00,
     > .9999E 00,.1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,
     > .1000E 01,.1000E 01,.1309E 00,.1612E 00,.1883E 00,.2366E 00,
     > .2801E 00,.3206E 00,.3588E 00,.3952E 00,.4300E 00,.4635E 00,
     > .4958E 00,.5713E 00,.6400E 00,.7018E 00,.7565E 00,.8450E 00,
     > .9075E 00,.9481E 00,.9725E 00,.9934E 00,.9981E 00,.9996E 00,
     > .9999E 00,.1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E C1,
     > .1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,
     > .1903E-01,.3428E-01,.5345E-01,.1034E 00,.1678E 00,.2443E 00,
     > .3296E 00,.4194E 00,.5092E 00,.5953E 00,.6741E 00,.8284E 00,
     > .9204E 00,.9661E 00,.9875E 00,.9984E 00,.9998E 00,.1000E 01/
      DATA BB/ .1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E
     > 01, .1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,.1000E 01,
     > .1000E 01,.1000E 01,.1000E 01,.1000E 01/
      DO 30 I=1,34
         DO 20 K=1,7
            DO 10 L=8,13
10             REFA(I,K,L)=SEFA(I,K,L)
20          CONTINUE
30       CONTINUE
      RETURN
      END
      SUBROUTINE QX(BND,X,U,UD,HS,VD,VG,INDEX1,QXR)
C
C-----NUMERICAL INTEGRATION BY SIMPSON'S RULE
C-----ROUTINE CHANGED BY D.P.STEWART 7/76
C
      FUNC(D,F,HH,X)=F*EXP(-(HH**2*F**2)/(2.*X**(2*D)))/X**D
      REAL AB(7,4,2)
      INTEGER AC(5,4)
C              1        2        3        4        5        6        7
      DATA AB/ 1.0000, 1.0000, .9540, .8061, .8600, .8823, .8257,
     > 99.9999,99.9999, .8330, .6715, .6290, .6321, .6547, 99.9999,
     > 99.9999, .5524, .5099, .4054, .3710, .3818, 99.9999,99.9999,
     > 99.9999, .5251, .1110, .1106, .1106, 5.0200, 8.3500,10.0150,
     > 7.4800,15.5000,34.7000,61.2500, 99.9999,99.9999, 4.4000, 2.9500,
     > 3.1500, 6.1320,18.8000, 99.9999,99.9999, .3320, .8100, .5240,
     > .7640, 2.1150, 99.9999,99.9999,99.9999, .9300, .0349, .0694,
     > .1739/
C              1     2     3     4     5
      DATA AC/ 0, 0,99999, 1000, 1000, 1000, 1000, 0,10000, 3000, 10000,
     >  3000, 0,99999,10000, 0,10000, 0, 0,99999/
      IF (INDEX1-3) 10,20,30
C-----SET UP BOUNDS OF INTEGRATION
C-----INDEX3 GIVES COLUMN OF AC CONTAINING LOWER BOUNDS
C-----INDEX4 GIVES COLUMN WITH UPPER BOUND
C-----LIM1 AND LIM2 DETERMINE  THE ROWS OF AC USED
C-----THEY ALSO DETERMINE WHICH VALUES OF D AND F SHOULD BE USED
   10 INDEX3=1
      INDEX4=3
      LIM2=1
      LIM1=1
      GO TO 40
   20 INDEX3=1
      INDEX4=4
      LIM2=3
      LIM1=1
      IF (BND.GE.1000.) LIM1=2
      IF (BND.GE.10000) LIM1=3
      GO TO 40
   30 INDEX3=2
      INDEX4=5
      LIM2=4
      LIM1=1
      IF (BND.GE.1000) LIM1=2
      IF (BND.GE.3000) LIM1=3
      IF (BND.GE.10000) LIM1=4
   40 QXR=0
      STOR1=AC(INDEX3,LIM1)
      AC(INDEX3,LIM1)=BND
      AC(INDEX4,LIM2)=X
      EPS=.1
C-----THIS LOOP SPLITS THE INTEGRATION ACCORDING TO CHANGES IN D AND F
      DO 90 INDEX2=LIM1,LIM2
         D=AB(INDEX1,INDEX2,1)
         F=AB(INDEX1,INDEX2,2)
         B=AC(INDEX4,INDEX2)
         IF (X.LT.B) B=X
         A=AC(INDEX3,INDEX2)
         WIDTH=(B-A)/2.
         JLIM=1
C-----FOPA AND FOPB ARE THE FUNCTION VALUES AT ENDPOINTS OF INTERVAL
         FOPA=0.0
         IF (A.EQ.0.0) GO TO 50
         HA=HS-VG*A/UD
         IF (HA.LT.1.0) HA=1.0
         FOPA=FUNC(D,F,HA,A)
   50    HB=HS-VG*B/UD
         IF (HB.LT.1.0) HB=1.0
         FOPB=FUNC(D,F,HB,B)
         X1=A+WIDTH
         H1=HS-VG*X1/UD
         IF (H1.LT.1.0) H1=1.0
C-----COMPUTE FIRST APPROXIMATION OF SIMP
         SIMP=(FOPA+4*FUNC(D,F,H1,X1)+FOPB)*WIDTH/3.
C-----THIS SECTION IS REPEATED UNTIL THE CHANGE IN SIMP IS LESS THAN EPS
   60    FUNC1=0.0
         FUNC2=0.0
         WIDTH=WIDTH/2
         JLIM=JLIM*2
         OLDS=SIMP
         JLESS=JLIM-1
         DO 70 J=1,JLESS
            X1=A+(2*J-1.)*WIDTH
            H1=HS-VG*X1/UD
            IF (H1.LT.1.0) H1=1.0
            FUNC1=FUNC1+FUNC(D,F,H1,X1)
            X2=A+2*J*WIDTH
            H2=HS-VG*X2/UD
            IF (H2.LT.1.0) H2=1.0
            FUNC2=FUNC2+FUNC(D,F,H2,X2)
   70       CONTINUE
         X1=A+2*JLIM*WIDTH
         H1=HS-VG*X1/UD
         IF (H1.LT.1.0) H1=1.0
         FUNC1=FUNC1+FUNC(D,F,H1,X1)
         SIMP=(FOPA+4*FUNC1+2*FUNC2+FOPB)*WIDTH/3
         IF (ABS(SIMP-OLDS).GT.EPS) GO TO 60
C-----END SIMP APPROXIMATION LOOP
   80    QXR=QXR+SIMP
         IF (X.LT.AC(INDEX4,INDEX2)) GO TO 100
   90    CONTINUE
  100 QXR=EXP(-.79788*QXR*VD/UD)
      AC(INDEX3,LIM1)=STOR1
      RETURN
      END
      SUBROUTINE CHIQ
      COMMON /OCOM/ NAMNUC(36),WORD,NNUCS,ANLAM(36),RR,SQSD, ACON(36,20,
     >  20),GCON(36,20,20),LIPO,NOMM(36,11),NRMM(36,11), ORMODI(36,12,8)
     > , VD(36),VDCOEF(20,20),NOL,NOU,NRL,NRU
      REAL*8 NAMNUC,WORD
      COMMON /PCOM/ REL(6,36),IDIST(20),NUMST
      COMMON /TCOM/ KIQ(36,20,20)
      DIMENSION REGL(35)
      REAL KIQ
      DO 30 I=1,NNUCS
         DO 20 NO=1,16
            DO 10 NR=1,20
   10          KIQ(I,NO,NR)=0
   20       CONTINUE
   30    CONTINUE
      DO 50 I=1,NNUCS
         REGL(I)=0
         DO 40 J=1,NUMST
   40       REGL(I)=REGL(I)+REL(J,I)
   50    CONTINUE
      DO 90 I=1,NNUCS
         DO 80 NO=NOL,NOU
            DO 60 NR=NRL,NRU
               IF (REGL(I).EQ.0) GO TO 70
   60          KIQ(I,NO,NR)=(ACON(I,NO,NR)/REGL(I))*1.E6
            GO TO 80
   70       KIQ(I,NO,NR)=0.
   80       CONTINUE
   90    CONTINUE
      DO 130 I=1,NNUCS
         WRITE(51,9000) NAMNUC(I)
         WRITE(51,9001)
         WRITE(51,9002)
         WRITE(51,9003)
         WRITE(51,9001)
         WRITE(51,9004)
         WRITE(51,9005)
         NO=1
         DO 100 NR=NRL,NRU
  100       WRITE(51,9007)IDIST(NR),KIQ(I,NO,NR),KIQ(I,NO+1,NR),KIQ(I,
     >        NO+2,NR),KIQ(I,NO+3,NR),KIQ(I,NO+4,NR),KIQ(I,NO+5,NR),
     >        KIQ(I,NO+6,NR), KIQ(I,NO+7,NR)
         ISP=(22-2*(NRU/2))/2
         DO 110 IG=1,ISP
  110       WRITE(51,9001)
         WRITE(51,9006)
         WRITE(51,9005)
         NO=9
         DO 120 NR=NRL,NRU
  120       WRITE(51,9007)IDIST(NR),KIQ(I,NO,NR),KIQ(I,NO+1,NR),KIQ(I,
     >        NO+2,NR),KIQ(I,NO+3,NR),KIQ(I,NO+4,NR),KIQ(I,NO+5,NR),
     >        KIQ(I,NO+5,NR), KIQ(I,NO+7,NR)
  130    CONTINUE
      RETURN
 9000 FORMAT('1',T25,'GROUND-LEVEL CHI/Q VALUES FOR ',A8,
     > 'AT VARIOUS DISTANCES IN EACH COMPASS DIRECTION')
```

```
9001 FORMAT('0')
9002 FORMAT(' ',T20,'DISTANCE',T52,'CHI/Q TOWARD INDICATED DIRECTION')
9003 FORMAT(' ',T20,'(METERS)',T60,'(SEC/CUBIC METER)')
9004 FORMAT(' ',T32,'N',T43,'NNW',T54,'NW',T65,'WNW',T76,'W',T87,'WSW',
    > T98,'SW',T109,'SSW')
9005 FORMAT(' ')
9006 FORMAT(' ',T32,'S',T43,'SSE',T54,'SE',T65,'ESE',T76,'E',T87,'ENE',
    > T98,'NE',T109,'NNE')
9007 FORMAT(' ',T19,I7,T30,E9.3,T41,E9.3,T52,E9.3,T63,E9.3,T74,E9.3,
    > T85,E9.3,T96,E9.3,T107,E9.3)
     END
```

```
      SUBROUTINE DIRECT(LORT)
C        READS AIR CONCENTRATIONS AND GROUND DEPOSITION RATES FOR
C        RADIONUCLIDES DIRECTLY FOR TRANSMISSION TO THE DOSEN
C        SUBROUTINE.
      COMMON /OCOM/ NAMNUC(36),WORD,NNUCS,ANLAM(36),RR,SQSD, ACON(36,20,
     >  20),GCON(36,20,20),LIPO,NOMM(36,11),NRMM(36,11), ORMODI(36,12,8)
     > , VD(36),VDCOEF(20,20),NOL,NOU,NRL,NRU
      COMMON /PCOM/ REL(6,36),IDIST(20),NUMST
      COMMON /FCOM/ FEQWL,INTPA(20,20)
      DIMENSION SC(36)
      REAL*8 NAMNUC,WORD
      READ(50,9000) NOL,NOU,NRL,NRU
      READ(50,9001) SQSD
      READ(50,9000) IDIST
      READ(50,9002) SEQWL
      READ(50,9000) NNUCS
      DO 10 I=1,NNUCS
         READ(50,9003) NAMNUC(I),VD(I),SC(I)
         READ(50,9004) ((ACON(I,NO,NR),NR=1,20),NO=1,20)
         READ(50,9004) ((GCON(I,NO,NR),NR=1,20),NO=1,20)
   10    CONTINUE
      FEQWL=SEQWL
      WRITE(51,9005)
      WRITE(51,9006)
      WRITE(51,9007)
      IF (LORT.EQ.0) GO TO 20
      WRITE(51,9008)
      WRITE(51,9009)
      WRITE(51,9019)
      GO TO 30
   20 WRITE(51,9010)
      WRITE(51,9019)
   30 CONTINUE
      IF (LORT.EQ.1) GO TO 70
      DO 60 NO=NOL,NOU
         DO 50 NR=NRL,NRU
            DO 40 I=1,NNUCS
               VD1=VD(I)
               DRYCON=ACON(I,NO,NR)*VD1*100
               WETCON=(GCON(I,NO,NR)-DRYCON)*(SC(I)/(SC(I)+1.E-30))
   40          WRITE(51,9018) NO,NR,NAMNUC(I),ACON(I,NO,NR),DRYCON,
     >          WETCON, GCON(I,NO,NR)
   50       CONTINUE
   60    CONTINUE
      GO TO 110
   70 CONTINUE
      DO 100 NO=NOL,NOU
         DO 90 NR=NRL,NRU
            DO 80 I=1,NNUCS
               VD1=VD(I)
               DRYCON=ACON(I,NO,NR)*VD1*100
               WETCON=(GCON(I,NO,NR)-DRYCON)*(SC(I)/(SC(I)+1.E-30))
   80          WRITE(51,9018) NO,IDIST(NR),NAMNUC(I),ACON(I,NO,NR),
     >          DRYCON,WETCON, GCON(I,NO,NR)
   90       CONTINUE
  100    CONTINUE
  110 CONTINUE
  120 CONTINUE
      IF (LORT.EQ.1) GO TO 130
      ASQSD=((SQSD**2)*400.)/1.E6
      WRITE(51,9011)
      WRITE(51,9012)ASQSD
      WRITE(51,9013)
      WRITE(51,9014)SQSD
      WRITE(51,9015)
      WRITE(51,9016)
      WRITE(51,9017)
C-----END OF GRID LOOP----------------------------------------
  130 RETURN
 9000 FORMAT(8I10)
 9001 FORMAT(8F10.0)
 9002 FORMAT(F10.0)
 9003 FORMAT(A8,F12.4,E10.3)
 9004 FORMAT(8E10.3)
 9005 FORMAT('1',T48,'INPUT RADIONUCLIDE CONCENTRATIONS')
 9006 FORMAT('0',T10,'AREA',T30,'NUCLIDE',T42,'AIR CONCENTRATION',T64,
     > 'DRY DEPOSITION RATE',T88,'WET DEPOSITION RATE',T112,
     > 'GROUND DEPOSITION RATE')
 9007 FORMAT(T47,'(PCI/CC)',T64,'(PCI/SQUARE CM-SEC)',T88,
     > '(PCI/SQUARE CM-SEC)',T113,'(PCI/SQUARE CM-SEC)')
 9008 FORMAT(' WIND TOWARD',T17,'DISTANCE')
 9009 FORMAT(' ',T17,'(METERS)')
 9010 FORMAT(' ',T4,'COLUMN',T21,'ROW')
 9011 FORMAT('1',T30,'NOTE-THE AREA SURROUNDING THE PLANT IS A SQUARE
     >WITH AN AREA')
 9012 FORMAT(' ',T35,'OF',F10.1,1X,
     > 'SQUARE KILOMETERS WITH THE PLANT AT THE CENTER.')
 9013 FORMAT(' ',T35,'THE SQUARE AREA IS ALIGNED DUE NORTH-SOUTH AND EAS
     >T-WEST. THE')
 9014 FORMAT(' ',T35,'400 SMALLER SQUARES, WHICH ARE EACH ',F7.1,1X,
     > 'METERS ON A SIDE,')
 9015 FORMAT(' ',T35,'ARE IDENTIFIED BY COLUMN AND ROW. COLUMNS ARE NUMB
     >ERED FROM')
 9016 FORMAT(' ',T35,'1 TO 20 FROM WEST TO EAST. ROWS ARE NUMBERED FROM
     >1 TO 20 FROM')
 9017 FORMAT(' ',T35,'SOUTH TO NORTH.')
 9018 FORMAT(' ',T6,I2,T18,I6,T31,A8,T45,E10.3,T68,E10.3,T92,E10.3,T118,
     >  E10.3)
 9019 FORMAT('0')
      END
      SUBROUTINE DOSEN
C
C       USNRC REG. GUIDE 1.109 MODELS FOR INGESTION DOSE CALCULATIONS
C       WERE IMPLEMENTED AND INCORPORATED WITHIN DOSEN BY J. C. PLEASANT
C       OF THE MATHEMATICS DEPARTMENT, EAST TENNESSEE STATE UNIVERSITY.
C
      COMMON /OCOM/ NAMNUC(36),WORD,NNUCS,ANLAM(36),RR,SQSD, ACON(36,20,
     >  20),GCON(36,20,20),LIPO,NOMM(36,11),NRMM(36,11), ORMODI(36,12,8)
     > , VD(36),VDCOEF(20,20),NOL,NOU,NRL,NRU
      COMMON /INGDOS/LAMW,TSUBB,P,BSUBV,DR,RATUA
      COMMON NOML(11),NRML(11)
      COMMON /RVAL/ S1,S3,SD1,SD3,ACN,GCN,SW1,SW3
      COMMON /TCOM/ KIQ(36,20,20)
      COMMON /PCOM/ REL(6,36),IDIST(20),NUMST
      COMMON /FCOM/ FEQWL,INTPA(20,20)
C
      DIMENSION VAGAC(36),VAGCON(36),BAGAC(36),BAGCON(36)
      DIMENSION FING(36,20,20),GBUP(36,20,20)
      DIMENSION GI(36,4),PARSIZ(36),CLASS(36)
      DIMENSION GFIN(36,20,20)
      REAL KIQ
      REAL*8 NADRN
      REAL*8 NAMNUC,WORD,NADEC1,NADEC3, NAMES(11),NAMORG(11)
      REAL CFINGA(11),CFINHA(11),DOSING(11),FROG(11),INTPA,
     > LAMH2O,LAMSUR,MSUBB,LAMRR,INTFC(20,20), DCC14(11),DOSIN(11,36),
     > VEGDOS(11),BEFDOS(11),MLKDOS(11), LAMI,LAMW,LEFDOS,MAGAC(36),
     > MAGCON(36)
      INTEGER INTWA(20,20),NOBCT(20,20),NOMCT(20,20),TNOBCT,TNOMCT
      INTEGER CLASS
      DATA NAMES/'TOT.BODY','R MAR   ','LUNGS   ','ENDOST  ','S WALL  ',
     > 'LLI WALL','THYROID ','LIVER   ','KIDNEYS ','TESTES  ',
     > 'OVARIES '/
      DATA NADRN/'RN-222  '/
      DATA NADEC1/'H-3     '/,NADEC3/'C-14    '/
      DATA DCC14/1.16E3,2.03E3,5.07E2,1.85E3,7.43E2,8.92E2,5.27E2,
     > 7.30E2,6.49E2,4.46E2,4.46E2/
C---END OF DECLARATIONS
      DO 10 K=1,36
         DO 10 J=1,11
            DOSIN(J,K)=0.
            DO 10 I=1,8
   10          ORMODI(K,J,I)=0
      DO 40 I=1,36
         DO 30 NO=1,20
            DO 20 NR=1,20
               GBUP(I,NO,NR)=0.
               FING(I,NO,NR)=0.
   20          CONTINUE
   30       CONTINUE
   40    CONTINUE
      READ(50,9061) LIPO
      READ(50,9061) NNTB,NRTB,NSTB,NTTB,NUTB
      READ(50,9062) ((NOBCT(I,J),J=1,20),I=1,20)
      READ(50,9063) ((NOMCT(I,J),J=1,20),I=1,20)
      READ(50,9064) ((INTFC(I,J),J=1,20),I=1,20)
      READ(50,9065) ((INTPA(I,J),J=1,20),I=1,20)
      READ(50,9066)((INTWA(I,J),J=1,20),I=1,20)
      READ(50,9067)IMPFIX
      READ(50,9068)RVEG,F3VEGM,RBEF,F3BEFM,RMLK,F3MLKM
      READ(50,9069)BRTHRT,DILFAC,USEFAC,T,DD1
C READ PARAMETERS FOR NRC MODEL
      READ(50,9000)TSUBH1,TSUBH2,TSUBH3,TSUBH4
      READ(50,9000)LAMW
      READ(50,9000)TSUBE1,TSUBE2
      READ(50,9000)YSUBV1,YSUBV2
      READ(50,9000)FSUBP
      READ(50,9000)FSUBS
      READ(50,9000)QSUBF
      READ(50,9000)TSUBF
      READ(50,9000)UV,UM,UF,UL
      READ(50,9000)TSUBS
      READ(50,9000)FSUBG,FSUBL
      READ(50,9000)TSUBB
      READ(50,9000)P
      READ(50,9070)TAUBEF,MSUBB,VSUBM
      TAUCM=UM/365.
      TAUBM=UF/365.
      V=(UL+UV)/365.
      A=(UV+UL)/YSUBV2
      READ(50,9070)R1,R2
      S10=R2
      S30=R1
      S1=R2
      S3=R1
      WRITE(51,9001)
      IF (LIPO.EQ.1) GO TO 50
      WRITE(51,9002)
      GO TO 60
   50 WRITE(51,9003)
   60 CONTINUE
      IF (NNTB.GT.0) GO TO 70
      WRITE(51,9004)
      GO TO 80
   70 WRITE(51,9005)NNTB
   80 CONTINUE
      IF (NRTB.NE.0) WRITE(51,9006)
      IF (NSTB.NE.0) WRITE(51,9007)
      IF (NTTB.NE.0) WRITE(51,9008)
      IF (NUTB.NE.0) WRITE(51,9009)
      WRITE(51,9071)
      WRITE(51,9072)
      WRITE(51,9072)
      WRITE(51,9073)
      WRITE(51,9074)
      WRITE(51,9075)
      WRITE(51,9076)
      WRITE(51,9072)
      DO 100 NO=1,20
          DO 90 NR=1,20
              WRITE(51,9077)NO,NR,NOBCT(NO,NR),NOMCT(NO,NR),INTFC(NO,NR),
     >         INTWA(NO,NR),INTPA(NO,NR)
C
   90         CONTINUE
  100     CONTINUE
```

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      WRITE(51,9078)                                                    DOSE 570
      WRITE(51,9079)                                                    DOSE 575
      WRITE(51,9080)NNUCS                                               DOSE 580
      WRITE(51,9012)TSUBH1                                              DOSE 585
      WRITE(51,9013)TSUBH2                                              DOSE 590
      WRITE(51,9014)TSUBH3                                              DOSE 595
      WRITE(51,9015)TSUBH4                                              DOSE 600
      WRITE(51,9016)LAMW                                                DOSE 605
      WRITE(51,9017)TSUBE1                                              DOSE 610
      WRITE(51,9018)TSUBE2                                              DOSE 615
      WRITE(51,9019)YSUBV1                                              DOSE 620
      WRITE(51,9020)YSUBV2                                              DOSE 625
      WRITE(51,9021)FSUBP                                               DOSE 630
      WRITE(51,9022)FSUBS                                               DOSE 635
      WRITE(51,9023)QSUBF                                               DOSE 640
      WRITE(51,9024)TSUBF                                               DOSE 645
      WRITE(51,9025)UV                                                  DOSE 650
      WRITE(51,9026)UM                                                  DOSE 655
      WRITE(51,9027)UF                                                  DOSE 660
      WRITE(51,9028)UL                                                  DOSE 665
      WRITE(51,9029)TSUBS                                               DOSE 670
      WRITE(51,9030)FSUBG                                               DOSE 675
      WRITE(51,9031)FSUBL                                               DOSE 680
      WRITE(51,9011)TSUBB                                               DOSE 685
      WRITE(51,9010)P                                                   DOSE 690
      WRITE(51,9081)RVEG                                                DOSE 695
      WRITE(51,9082)RBEF                                                DOSE 700
      WRITE(51,9083)RMLK                                                DOSE 705
      WRITE(51,9072)                                                    DOSE 710
      IF (IMPFIX.EQ.0) GO TO 110                                        DOSE 715
      WRITE(51,9084)                                                    DOSE 720
      GO TO 120                                                         DOSE 725
  110 WRITE(51,9085)                                                    DOSE 730
  120 WRITE(51,9086)P3VEGM                                              DOSE 735
      WRITE(51,9087)P3BEFM                                              DOSE 740
      WRITE(51,9088)P3MLKM                                              DOSE 745
      WRITE(51,9089)BRTHRT                                              DOSE 750
      WRITE(51,9090)T                                                   DOSE 755
      WRITE(51,9091)DILFAC                                              DOSE 760
      WRITE(51,9092)USEFAC                                              DOSE 765
      WRITE(51,9093)MSUBB                                               DOSE 770
      WRITE(51,9096)TAUBEF                                              DOSE 775
      WRITE(51,9097)VSUBM                                               DOSE 780
      WRITE(51,9094)S1                                                  DOSE 785
      WRITE(51,9095)S3                                                  DOSE 790
      WRITE(51,9098)DD1                                                 DOSE 795
      TPOP=0                                                            DOSE 800
      TNOBCT=0                                                          DOSE 805
      TNOMCT=0                                                          DOSE 810
      TARFC=0                                                           DOSE 815
      DO 140 NO=NOL,NOU                                                 DOSE 820
         DO 130 NR=NRL,NRU                                              DOSE 825
            TPOP=INTPA(NO,NR)+TPOP                                      DOSE 830
            TNOBCT=NOBCT(NO,NR)+TNOBCT                                  DOSE 835
            TNOMCT=NOMCT(NO,NR)+TNOMCT                                  DOSE 840
  130       TARFC=INTPC(NO,NR)+TARFC                                    DOSE 845
  140    CONTINUE                                                       DOSE 850
      ANUMM=TARFC/A                                                     DOSE 855
      TKGBCA=TAUBM*365.*TPOP
      ANOBCT=TNOBCT
      TKGBPA=ANOBCT*TAUBEF*365.*MSUBB
      CONMK=TAUCM*TPOP
      ANOMCT=TNOMCT
      PRNMK=VSUBM*ANOMCT
      YCONMK=CONMK*365.
      YPRNMK=PRNMK*365.
      PFCY=YSUBV2*TARFC
      CFCY=TPOP*V*365.
      AF=ANUMM/TPOP
      IF (ANUMM.GE.TPOP) AF=1.
      F3V=F3VEGM
      IF ((1.-AF).GE.F3V) F3V=1.-AF
      IF (IMPFIX.EQ.1) F3V=F3VEGM
      F1V=RVEG*(1.-F3V)
      F2V=1.-F3V-F1V
      BF=TKGBPA/TKGBCA
      IF (TKGBPA.GE.TKGBCA) BF=1.
      F3B=F3BEFM
      IF ((1.-BF).GE.F3B) F3B=1.-BF
      IF (IMPFIX.EQ.1) F3B=F3BEFM
      F1B=RBEF*(1.-F3B)
      F2B=1.-F3B-F1B
      CF=PRNMK/CONMK
      IF (PRNMK.GE.CONMK) CF=1.
      F3M=F3MLKM
      IF ((1.-CF).GE.F3M) F3M=1.-CF
      IF (IMPFIX.EQ.1) F3M=F3MLKM
      F1M=RMLK*(1.-F3M)
      F2M=1.-F3M-F1M
      WRITE(51,9099)
      WRITE(51,9100)TPOP
      WRITE(51,9101)TNOBCT
      WRITE(51,9102)TNOMCT
      WRITE(51,9103)TARFC
      WRITE(51,9104)TKGBCA
      WRITE(51,9105)TKGBPA
      WRITE(51,9106)YCONMK
      WRITE(51,9107)YPRNMK
      WRITE(51,9108)CFCY
      WRITE(51,9109)PFCY
      DO 680 I = 1, NNUCS
         READ(50,9110)NUMORG,LAMRR,CFSBA,CFSBW,CFSUR,KFLAG,TDCF,TDCW
         READ(50,9111)(PROG(IM),IM=1,11)
         READ(50,9000)FSUBMI,FSUBFI,BSUBV1,BSUBV2
         READ(50,9112)LAMSUR,LAMH2O,IFLAG,RD1,RD2,RW1,RW2
         READ(50,9032)I1,I2,I3,I4,I5,F1,F2,F3,F4,F5
         LAMI = LAMRR/24.
C  IFLAG=1 IF SPECIAL VALUES USED FOR R1 AND R2
C  IFLAG=2 IF R1 AND R2 ARE GIVEN FOR DRY AND WET DEPOSITION
         SD3=RD1
         SD1=RD2
         SW3=RW1
         SW1=RW2
C READ INHALATION DOSE CONVERSION FACTORS
C HEADER CARD GIVES  SOLUBILITY, PARTICLE SIZE, AND G.I. UPTAKE FRACTION
         READ(50,9033)ISOL,AMAD,F1INH
      DO 150 J=1,NUMORG                                                 DOSE1150
         READ(50,9034) NAMORG(J),CFINHA(J)                              DOSE1155
  150    CONTINUE                                                       DOSE1160
C READ INGESTION DOSE CONVERSION FACTORS                                 DOSE1165
C HEADER CARD GIVES G.I. UPTAKE FRACTION                                DOSE1170
      READ(50,9035) F1ING                                               DOSE1175
      DO 160 J=1,NUMORG                                                 DOSE1180
         READ(50,9035) CFINGA(J)                                        DOSE1185
  160    CONTINUE                                                       DOSE1190
      CLASS(I)=ISOL                                                     DOSE1195
      PARSIZ(I)=AMAD                                                    DOSE1200
      GI(I,1)=F1INH                                                     DOSE1205
      GI(I,2)=F1ING                                                     DOSE1210
      IF (I1.EQ.0) GO TO 170                                            DOSE1215
      IF (I2.EQ.0) I2=1                                                 DOSE1220
      IF (I3.EQ.0) I3=1                                                 DOSE1225
      IF (I4.EQ.0) I4=1                                                 DOSE1230
      IF (I5.EQ.0) I5=1                                                 DOSE1235
  170 CONTINUE                                                          DOSE1240
      IF (I.GT.NNTB) GO TO 180                                          DOSE1245
      WRITE(51,9113) NAMNUC(I)                                          DOSE1250
      WRITE(51,9072)                                                    DOSE1255
      WRITE(51,9114)                                                    DOSE1260
      WRITE(51,9115)                                                    DOSE1265
      WRITE(51,9072)                                                    DOSE1270
      WRITE(51,9116)                                                    DOSE1275
      WRITE(51,9117)                                                    DOSE1280
      WRITE(51,9072)                                                    DOSE1285
  180 VAGCON(I)=0.                                                      DOSE1290
      BAGCON(I)=0.                                                      DOSE1295
      MAGCON(I)=0.                                                      DOSE1300
      VAGAC(I)=0.                                                       DOSE1305
      BAGAC(I)=0.                                                       DOSE1310
      MAGAC(I)=0.                                                       DOSE1315
      IF (I1.NE.0) GO TO 210                                            DOSE1320
      DO 200 NO=NOL,NOU                                                 DOSE1325
         DO 190 NR=NRL,NRU                                              DOSE1330
            VAGCON(I)=INTFC(NO,NR)*GCON(I,NO,NR)+VAGCON(I)              DOSE1335
            BAGCON(I)=NOBCT(NO,NR)*GCON(I,NO,NR)+BAGCON(I)              DOSE1340
            MAGCON(I)=NOMCT(NO,NR)*GCON(I,NO,NR)+MAGCON(I)              DOSE1345
            VAGAC(I)=INTFC(NO,NR)*ACON(I,NO,NR)+VAGAC(I)                DOSE1350
            BAGAC(I)=NOBCT(NO,NR)*ACON(I,NO,NR)+BAGAC(I)                DOSE1355
            MAGAC(I)=NOMCT(NO,NR)*ACON(I,NO,NR)+MAGAC(I)                DOSE1360
  190       CONTINUE                                                    DOSE1365
  200    CONTINUE                                                       DOSE1370
      VAGCON(I)=VAGCON(I)/TARFC                                         DOSE1375
      BAGCON(I)=BAGCON(I)/ANOBCT                                        DOSE1380
      MAGCON(I)=MAGCON(I)/ANOMCT                                        DOSE1385
      VAGAC(I)=VAGAC(I)/TARFC                                           DOSE1390
      BAGAC(I)=BAGAC(I)/ANOBCT                                          DOSE1395
      MAGAC(I)=MAGAC(I)/ANOMCT                                          DOSE1400
      GO TO 290                                                         DOSE1405
  210 IF (REL(1,I).NE.0.) GO TO 240                                     DOSE1410
      DO 230 NO=NOL,NOU                                                 DOSE1415
         DO 220 NR=NRL,NRU                                              DOSE1420
            GCI=F1*GCON(I1,NO,NR)+F2*GCON(I2,NO,NR)+F3*GCON(I3,NO,NR)   DOSE1425
   >         + F4*GCON(I4,NO,NR)+F5*GCON(I5,NO,NR)                      DOSE1430
            VAGCON(I)=INTFC(NO,NR)*GCI+VAGCON(I)                        DOSE1435
            BAGCON(I)=NOBCT(NO,NR)*GCI+BAGCON(I)                        DOSE1440
            MAGCON(I)=NOMCT(NO,NR)*GCI+MAGCON(I)                        DOSE1445
220         CONTINUE                                                    DOSE1450
230      CONTINUE                                                       DOSE1455
      VAGCON(I)=VAGCON(I)/TARFC                                         DOSE1460
      BAGCON(I)=BAGCON(I)/ANOBCT                                        DOSE1465
      MAGCON(I)=MAGCON(I)/ANOMCT                                        DOSE1470
      GO TO 290                                                         DOSE1475
240   MODE=1                                                            DOSE1480
      BSUBV=BSUBV2                                                      DOSE1485
      TSUBE=TSUBE2                                                      DOSE1490
      YSUBV=YSUBV2                                                      DOSE1495
      TSUBH=TSUBH4                                                      DOSE1500
      DR=DD1                                                            DOSE1505
      DO 260 NO=NOL,NOU                                                 DOSE1510
         DO 250 NR=NRL,NRU                                              DOSE1515
            GCN=GCON(I,NO,NR)                                           DOSE1520
            ACN=ACON(I,NO,NR)                                           DOSE1525
            CALL RVALUE(IFLAG,MODE,I,NO,NR,R)                           DOSE1530
            A=CV(I,LAMI,1.,1.,TSUBE,YSUBV,TSUBH,R)                      DOSE1535
            GCI=F1*GCON(I1,NO,NR)+F2*GCON(I2,NO,NR)+F3*GCON(I3,NO,NR)  DOSE1540
    >        + F4*GCON(I4,NO,NR)+F5*GCON(I5,NO,NR)                      DOSE1545
            GFA=GCON(I,NO,NR)+RATUA*GCI                                 DOSE1550
            VAGCON(I)=INTFC(NO,NR)*GFA+VAGCON(I)                        DOSE1555
250         CONTINUE                                                    DOSE1560
260      CONTINUE                                                       DOSE1565
      VAGCON(I)=VAGCON(I)/TARFC                                         DOSE1570
      MODE=2                                                            DOSE1575
      DR=1.                                                             DOSE1580
      TSUBE=TSUBE1                                                      DOSE1585
      YSUBV=YSUBV1                                                      DOSE1590
      BSUBV=BSUBV1                                                      DOSE1595
      TSUBH=TSUBH1                                                      DOSE1600
      DO 280 NO=NOL,NOU                                                 DOSE1605
         DO 270 NR=NRL,NRU                                              DOSE1610
            GCN=GCON(I,NO,NR)                                           DOSE1615
            ACN=ACON(I,NO,NR)                                           DOSE1620
            CALL RVALUE(IFLAG,MODE,I,NO,NR,R)                           DOSE1625
            A=CV(I,LAMI,1.,1.,TSUBE,YSUBV,TSUBH,R)                      DOSE1630
            GCI=F1*GCON(I1,NO,NR)+F2*GCON(I2,NO,NR)+F3*GCON(I3,NO,NR)  DOSE1635
    >        + F4*GCON(I4,NO,NR)+F5*GCON(I5,NO,NR)                      DOSE1640
            GFA=GCON(I,NO,NR)+RATUA*GCI                                 DOSE1645
            BAGCON(I)=NOBCT(NO,NR)*GFA+BAGCON(I)                        DOSE1650
            MAGCON(I)=NOMCT(NO,NR)*GFA+MAGCON(I)                        DOSE1655
270         CONTINUE                                                    DOSE1660
280      CONTINUE                                                       DOSE1665
      BAGCON(I)=BAGCON(I)/ANOBCT                                        DOSE1670
      MAGCON(I)=MAGCON(I)/ANOMCT                                        DOSE1675
290   CONTINUE                                                          DOSE1680
      IF (NAMNUC(I)-NADEC1) 300,310,300                                 DOSE1685
300   NTRIT = 0                                                         DOSE1690
      GO TO 320                                                         DOSE1695
310   NTRIT = 1                                                         DOSE1700
320   CONTINUE                                                          DOSE1705
      DO 560 NO=NOL,NOU                                                 DOSE1710
         DO 550 NR=NRL,NRU                                              DOSE1715
            GCI=0                                                       DOSE1720
            IF (I1.EQ.0) GO TO 330                                      DOSE1725
            GCI=F1*GCON(I1,NO,NR)+F2*GCON(I2,NO,NR)+F3*GCON(I3,NO,NR) DOSE1730
     >        + F4*GCON(I4,NO,NR)+F5*GCON(I5,NO,NR)                    DOSE1735
  330       GCN=GCON(I,NO,NR)+GCI                                      DOSE1740
  340       ACN=ACON(I,NO,NR)                                          DOSE1745
            IF (I1.NE.0) GO TO 350                                     DOSE1750
            D1=1.                                                      DOSE1755
            D2=1.                                                      DOSE1760
            D3=1.                                                      DOSE1765
            D4=1.                                                      DOSE1770
            IF (GCON(I,NO,NR).EQ.0.) GO TO 350                         DOSE1775
            D4=F1M+F2M*(MAGCON(I)/GCON(I,NO,NR))                       DOSE1780
            D3=F1B+F2B*(BAGCON(I)/GCON(I,NO,NR))                       DOSE1785
            D2=F1V+F2V*(VAGCON(I)/GCON(I,NO,NR))                       DOSE1790
            D1=D2                                                      DOSE1795
            GO TO 360                                                  DOSE1800
  350       IF (REL(1,I).NE.0.) GO TO 360                              DOSE1805
            D4=F1M+F2M*(MAGCON(I)/GCI)                                 DOSE1810
            D3=F1B+F2B*(BAGCON(I)/GCI)                                 DOSE1815
            D2=F1V+F2V*(VAGCON(I)/GCI)                                 DOSE1820
            D1=D2                                                      DOSE1825
  360       CONTINUE                                                   DOSE1830
  370       DO 540 J=1,11                                              DOSE1835
               X=LAMRR+LAMSUR                                          DOSE1840
               IF (KFLAG.EQ.1) X=ANLAM(I)+LAMSUR                       DOSE1845
               DO 380 N=1,NUMORG                                       DOSE1850
                  IF (NAMES(J)-NAMORG(N)) 380,390,380                  DOSE1855
  380             CONTINUE                                             DOSE1860
               L=1                                                     DOSE1865
               GO TO 400                                               DOSE1870
  390          L=N                                                     DOSE1875
C  INHALATION DOSE CALCULATIONS                                        DOSE1880
  400          CFINH=CFINHA(L)                                         DOSE1885
               CFING=CFINGA(L)                                         DOSE1890
               IF (ACN.EQ.0) DOS1=0                                    DOSE1895
               IF (ACN.EQ.0) DOS2=0                                    DOSE1900
               IF (ACN.EQ.0.) GO TO 410                                DOSE1905
               DOS1=ACN*1.E-6*BRTHRT*8760.*CFINH                       DOSE1910
C  AIR SUBMERSION DOSE CALCULATIONS                                    DOSE1915
               DOS2=ACN*1.E-6*8760.*CFSBA*FROG(J)                      DOSE1920
C  SURFACE EXPOSURE DOSE CALCULATIONS                                  DOSE1925
  410          ALT=X*T                                                 DOSE1930
               IF (ALT.GT.0.03) GO TO 420                              DOSE1935
               DOS3=GCN*1.E-6*8760.*CFSUR*FROG(J)*((0.1666667*ALT-     DOSE1940
     >          0.5)*ALT+T) *3600.*24.                                 DOSE1945
               GBUP(I,NO,NR)=GCN*1.E-8*24.*3600.* ((0.1666667*ALT-     DOSE1950
     >          0.5)*ALT+T)                                            DOSE1955
               GO TO 430                                               DOSE1960
  420          DOS3=GCN*1.E-6*8760.*CFSUR*FROG(J)*(1-EXP(-X*T))/X*     DOSE1965
     >          3600.*24.                                              DOSE1970
               GBUP(I,NO,NR)=GCN*1.E-8*24.*3600.*(1.-EXP(-X*T))/X      DOSE1975
C  INGESTION DOSE CALCULATIONS                                         DOSE1980
  430          IF (NTRIT.NE.1.AND.NAMNUC(I).NE.NADEC3) GO TO 450       DOSE1985
               IF (NTRIT.NE.1) GO TO 440                               DOSE1990
C  INGESTION DOSE CALCULATIONS FOR H-3                                 DOSE1995
               VEGDOS(J)=(F1V*ACN+F2V*VAGAC(I))*TDCF*.505              DOSE2000
               BEFDOS(J)=(F1B*ACN+F2B*BAGAC(I))*TDCF*.185              DOSE2005
               MLKDOS(J)=(F1M*ACN+F2M*MAGAC(I))*TDCF*.310              DOSE2010
               DOSING(J)=VEGDOS(J)+BEFDOS(J)+MLKDOS(J)+ACN*TDCW        DOSE2015
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                   KIQ(I,NO,NR)=(((F1V*ACN+F2V*VAGAC(I))*1.E6)/8.)*1560.*DOSE2020
    >               .505*365.+(((ACN*1.E6)/8.)*1440.*365.)*(TDCW/5.70)    DOSE2021
                   GFIN(I,NO,NR)=(((F1B*ACN+F2B*BAGAC(I))*1.E6)/8.)*1560.DOSE2025
    >               *.185*365.                                            DOSE2026
                   FING(I,NO,NR)=(((F1M*ACN+F2M*MAGAC(I))*1.E6)/8.)*1560.DOSE2030
    >               *.310*365.                                            DOSE2031
                   TDCWB=TDCW                                             DOSE2034
                   GO TO 480                                              DOSE2035
  440              CONTINUE                                               DOSE2040
C  INGESTION DOSE CALCULATIONS FOR C-14                                   DOSE2045
                   WTCV=79.96*V                                           DOSE2050
                   WTCB=238.16*TAUBM                                      DOSE2055
                   WTCM=68.9*TAUCM                                        DOSE2060
                   WTF=WTCV+WTCB+WTCM                                     DOSE2065
                   DOSING(J)=(DCC14(J)/WTF)*(WTCV*(F1V*ACN+F2V*VAGAC(I))+DOSE2070
    >                WTCB*(F1B*ACN+F2B*BAGAC(I))+WTCM*(F1M*ACN+F2M*       DOSE2075
    >               MAGAC(I)))                                            DOSE2080
                   VEGDOS(J)=(DCC14(J)/WTF)*(WTCV*(F1V*ACN+F2V*VAGAC(I)))DOSE2085
                   BEFDOS(J)=(DCC14(J)/WTF)*(WTCV*(F1B*ACN+F2B*BAGAC(I)))DOSE2090
                   MLKDOS(J)=(DCC14(J)/WTF)*(WTCV*(F1M*ACN+F2M*MAGAC(I)))DOSE2095
                   KIQ(I,NO,NR)=((F1V*ACN+F2V*VAGAC(I))/1.8E-7)*WTCV*365.DOSE2100
                   GFIN(I,NO,NR)=((F1B*ACN+F2B*BAGAC(I))/1.8E-7)*WTCB*365DOSE2105
    >               .                                                     DOSE2106
                   FING(I,NO,NR)=((F1M*ACN+F2M*MAGAC(I))/1.8E-7)*WTCM*365DOSE2110
    >               .                                                     DOSE2111
                   GO TO 480                                              DOSE2115
C  INGESTION DOSES DEFINED AS ZERO IF GROUND CONCENTRATION IS ZERO        DOSE2120
  450              IF (GCN.NE.0) GO TO 460                                DOSE2125
                   DOSING(J)=0.                                           DOSE2130
                   VEGDOS(J)=0.                                           DOSE2135
                   BEFDOS(J)=0.                                           DOSE2140
                   MLKDOS(J)=0.                                           DOSE2145
                   KIQ(I,NO,NR)=0.                                        DOSE2150
                   GFIN(I,NO,NR)=0.                                       DOSE2155
                   FING(I,NO,NR)=0.                                       DOSE2160
                   GO TO 480                                              DOSE2165
C INGESTION DOSE CALCULATIONS USING NRC MODEL                             DOSE2170
C CALCULATE CIV=CONCENTRATION OF RADIONUCLIDE IN THE ANIMAL'S FEED USINGDOSE2175
C SLIGHTLY SIMPLIFIED FORM OF EQ C-11, REG GUIDE 1.109.27.                DOSE2180
C CIV= FSUBP*FSUBS*(CONC. OF NUCLIDE ON PASTURE GRASS)                    DOSE2185
C      + (1.0-FSUBP*FSUBS)*(CONC. OF NUCLIDE IN STORED FEEDS)             DOSE2190
C USE PARAMETERS FOR GRASS-COW-MILK-MAN-PATHWAY                           DOSE2195
C FIRST TERM..  USE TSUBH VALUE FOR INGESTION BY ANIMALS OF PASTURE GRASDOSE2200
C THE DEPOSITION RATE GCN IS IN UNITS OF PCI/SQUARE CM-SEC.               DOSE2205
C TO CONVERT TO PCI/SQUARE METER-HR,MULTIPLY BY 3.6E7.                    DOSE2210
  460              DEPRAT= GCN*3.6E7                                      DOSE2215
                   GCRU=GCON(I,NO,NR)*3.6E7                               DOSE2220
                   GCN=GCRU/3.6E7                                         DOSE2225
                   TSUBH=TSUBH1                                           DOSE2230
                   TSUBE=TSUBE1                                           DOSE2235
                   YSUBV=YSUBV1                                           DOSE2240
                   BSUBV=BSUBV1                                           DOSE2245
C LAMI IS THE RADIOACTIVE DECAY CONSTANT OF NUCLIDE I, IN HR**-1.         DOSE2250
                   LAMI = LAMRR/24.                                       DOSE2255
                   MODE=2                                                 DOSE2260
                   CALL RVALUE(IFLAG,MODE,I,NO,NR,R)                      DOSE2265
                   DR=1.                                                  DOSE2270
                   TERM1=FSUBP*FSUBS *CV(I,LAMI,DEPRAT,GCRU,TSUBE,YSUBV,  DOSE2275
     >             TSUBH,R)                                             DOSE2280
C SECOND TERM..  USE TSUBH VALUE FOR INGESTION BY ANIMALS OF STORED FEEDDOSE2285
                  TSUBH=TSUBH2                                          DOSE2290
                  TERM2=(1.0-FSUBP*FSUBS)*CV(I,LAMI,DEPRAT,GCRU,TSUBE,  DOSE2295
     >             YSUBV,TSUBH,R)                                       DOSE2300
                  CIV=TERM1 + TERM2                                     DOSE2305
C                                                                       DOSE2310
C CALCULATE CIM=NUCLIDE CONCENTRATION IN MILK USING EQ C-10, REG GUIDE  DOSE2315
C 1.109-27                                                              DOSE2320
                  CIM=FSUBMI*CIV*QSUBF*EXP(-LAMRR*TSUBF)                DOSE2325
C DFIJ IS THE DOSE CONVERSION FACTOR FOR THE INGESTION OF NUCLIDE I, ORGDOSE2330
C IN MREM/PCI.                                                          DOSE2335
                  DFIJ = 0.001*CFING                                    DOSE2340
C CALCULATE MLKDOS(J)=ANNUAL DOSE TO ORGAN J FROM INGESTION OF RADIONUCLDOSE2345
C IN MILK USING EQ C-13,  REG GUIDE 1.109-28.                           DOSE2350
                  IF (I1.NE.0.AND.REL(1,I).NE.0.) D4=F1M+F2M*(MAGCON(I)/DOSE2355
     >              (GCON(I,NO,NR)+RATUA*GCI))                          DOSE2360
                  IF (I1.NE.0.AND.REL(1,I).NE.0.) D3=F1B+F2B*(BAGCON(I)/DOSE2365
     >              (GCON(I,NO,NR)+RATUA*GCI))                          DOSE2370
                  MLKDOS(J)=DFIJ*UM*CIM*D4                              DOSE2375
C THE NRC MODEL GIVES DOSES IN MREM/YR.  TO CONVERT TO REM/YR,          DOSE2380
C MULTIPLY BY 0.001                                                     DOSE2385
                  MLKDOS(J) = MLKDOS(J)*.001                            DOSE2390
C CALCULATE CIF=NUCLIDE CONCENTRATION IN MEAT USING EQ C-12, REG GUIDE 1DOSE2395
                  CIF=FSUBFI*CIV*QSUBF*EXP(-LAMRR *TSUBS)               DOSE2400
C CALCULATE BEFDOS(J)=ANNUAL DOSE TO ORGAN J FROM INGESTION OF          DOSE2405
C RADIONUCLIDE I IN MEAT.  (REG GUIDE 1.109-28, EQ C-13)                DOSE2410
                  BEFDOS(J)=DFIJ*UF*CIF*D3                              DOSE2415
                  BEFDOS(J) = BEFDOS(J) *.001                           DOSE2420
C CALCULATE CIVP=CONCENTRATION OF RADIONUCLIDE IN PRODUCE CONSUMED BY MADOSE2425
C USE PARAMETERS FOR CROP/VEGETATION-MAN PATHWAY., TSUBH VALUE FOR PRODUDOSE2430
                  TSUBE= TSUBE2                                         DOSE2435
                  YSUBV= YSUBV2                                         DOSE2440
                  TSUBH= TSUBH4                                         DOSE2445
                  BSUBV=BSUBV2                                          DOSE2450
                  DR=DD1                                                DOSE2455
                  MODE=1                                                DOSE2460
                  CALL RVALUE(IFLAG,MODE,I,NO,NR,R)                     DOSE2465
                  CIVP=CV(I,LAMI,DEPRAT,GCRU,TSUBE,YSUBV,TSUBH,R)       DOSE2470
C CALCULATE PRODOS=ANNUAL DOSE TO ORGAN J FROM INGESTION BY MAN OF RADIODOSE2475
C IN PRODUCE.   (REG GUIDE 1.109-28, EQ C-13)                           DOSE2480
                  IF (I1.NE.0.AND.REL(1,I).NE.0.) D2=F1V+F2V*(VAGCON(I)/DOSE2485
     >              (GCON(I,NO,NR)+RATUA*GCI))                          DOSE2490
                  D1=D2                                                 DOSE2495
                  PRODOS=DFIJ*UV*FSUBG*CIVP*D2                          DOSE2500
C CALCULATE CIVL=CONCENTRATION OF RADIONUCLIDE IN LEAFY VEGETABLES.     DOSE2505
C USE PARAMETERS FOR CROP/VEGETATION-MAN PATHWAY.                       DOSE2510
C THE TSUBH VALUE IS FOR LEAFY VEGETABLES.                              DOSE2515
                  TSUBE=TSUBE2                                          DOSE2520
                  YSUBV=YSUBV2                                          DOSE2525
                  TSUBH=TSUBH3                                          DOSE2530
                  BSUBV=BSUBV2                                          DOSE2535
                  DR=DD1                                                DOSE2540
                  CIVL=CV(I,LAMI,DEPRAT,GCRU,TSUBE,YSUBV,TSUBH,R)       DOSE2545
C CALCULATE LEFDOS=ANNUAL DOSE TO ORGAN J FROM INGESTION OF RADIONUCLIDEDOSE2550
C IN LEAFY VEGETABLES.   (REG GUIDE 1.109-28, EQ C-13)                  DOSE2555
                  LEFDOS=DFIJ*UL*FSUBL*CIVL*D1                          DOSE2560
C VEGDOS(J) IS THE ANNUAL DOSE TO ORGAN J FROM INGESTION OF RADIONUCLIDEDOSE2565
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C IN PRODUCE AND LEAFY VEGETABLES.
                 VEGDOS(J)=PRODOS + LEFDOS
                 VEGDOS(J) = VEGDOS(J)*.001
                 DOSING(J)=BEFDOS(J) + MLKDOS(J) + VEGDOS(J)
                 IF (J.NE.11) GO TO 470
                 KIQ(I,NO,NR)=UL*FSUBL*CIVL*D1+UV*FSUBG*CIVP*D2
                 GFIN(I,NO,NR)=UF*CIF*D3
                 FING(I,NO,NR)=UM*CIM*D4
  470            GCN=DEPRAT/3.6E7
C  WATER SUBMERSION DOSE CALCULATIONS
  480            X=LAMRR+LAMH2O
                 IF (KFLAG.EQ.1) X=ANLAM(I)+LAMH2O
  490            IF (GCN.EQ.0) DOS5=0
                 IF (GCN.EQ.0) GO TO 510
                 ALT=X*T
                 IF (ALT.GT.0.03) GO TO 500
                 DOS5=GCN*1.E-6*8760.*CFSBW*FROG(J)*USEFAC/DILFAC*
     >            ((0.1666667* ALT-0.5)*ALT+T)*3600.*24.
                 GO TO 510
  500            DOS5=GCN*1.E-6*8760.*CFSBW*FROG(J)*USEFAC/DILFAC*(1-
     >            EXP(-X*T))/X *3600.*24.
  510            TDOS=DOS1+DOS2+DOS3+DOSING(J)+DOS5
                 IF (I.GT.NNTB) GO TO 520
                 WRITE(51,9118)NO,NR,NAMES(J),DOS1,DOS2,DOS3,DOSING(J),
     >              DOS5,TDOS
  520            CONTINUE
                 IF (LIPO.EQ.0) GO TO 530
C POPULATION DOSE CALCULATIONS
                 ORMODI(I,J,1)=DOS1*INTPA(NO,NR)+ORMODI(I,J,1)
                 ORMODI(I,J,2)=DOS2*INTPA(NO,NR)+ORMODI(I,J,2)
                 ORMODI(I,J,3)=DOS3*INTPA(NO,NR)+ORMODI(I,J,3)
                 ORMODI(I,J,4)=DOSING(J)*INTPA(NO,NR)+ORMODI(I,J,4)
                 ORMODI(I,J,5)=DOS5*INTPA(NO,NR)+ORMODI(I,J,5)
                 ORMODI(I,J,6)=VEGDOS(J)*INTPA(NO,NR)+ORMODI(I,J,6)
                 ORMODI(I,J,7)=BEFDOS(J)*INTPA(NO,NR)+ORMODI(I,J,7)
                 ORMODI(I,J,8)=MLKDOS(J)*INTPA(NO,NR)+ORMODI(I,J,8)
                 GO TO 540
C  CALCULATIONS OF THE HIGHEST INDIVIDUAL DOSE FOR EACH RADIONUCLIDE
C  AND ORGAN AND GRID LOCATION WHERE RECEIVED
  530            IF (TDOS.LE.DOSIN(J,I)) GO TO 540
                 NOMM(I,J)=NO
                 NRMM(I,J)=NR
                 ORMODI(I,J,1)=DOS1
                 ORMODI(I,J,2)=DOS2
                 ORMODI(I,J,3)=DOS3
                 ORMODI(I,J,4)=DOSING(J)
                 ORMODI(I,J,5)=DOS5
                 ORMODI(I,J,6)=VEGDOS(J)
                 ORMODI(I,J,7)=BEFDOS(J)
                 ORMODI(I,J,8)=MLKDOS(J)
                 DOSIN(J,I)=TDOS
  540            CONTINUE
  550         CONTINUE
  560      CONTINUE
  570   CONTINUE
  580   WRITE(51,9119)NAMNUC(I)
        IF (IFLAG.GT.2.OR.IFLAG.LT.0) PRINT 9120
  590   IF (IFLAG.NE.1) GO TO 600
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      WRITE(51,9121) SD1                                                DOSE2860
      WRITE(51,9122) SD3                                                DOSE2865
600   IF (IFLAG.NE.2) GO TO 610                                         DOSE2870
      WRITE(51,9123) SD1                                                DOSE2875
      WRITE(51,9124) SW1                                                DOSE2880
      WRITE(51,9125) SD3                                                DOSE2885
      WRITE(51,9126) SW3                                                DOSE2890
610   WRITE(51,9127) LAMRR                                              DOSE2895
      IF (KFLAG.NE.1) GO TO 620                                         DOSE2900
      WRITE(51,9128)                                                    DOSE2905
      WRITE(51,9129)                                                    DOSE2910
620   WRITE(51,9130) LAMSUR                                             DOSE2915
      WRITE(51,9131) LAMH2O                                             DOSE2920
      IF (NTRIT.NE.1) GO TO 630                                         DOSE2925
      WRITE(51,9132) TDCF                                               DOSE2930
      WRITE(51,9133) TDCW                                               DOSE2935
630   IF (NTRIT.EQ.1) GO TO 650                                         DOSE2940
      WRITE(51,9036)  FSUBMI                                            DOSE2945
      WRITE(51,9037)  FSUBFI                                            DOSE2950
      WRITE(51,9038)  BSUBV1                                            DOSE2955
      WRITE(51,9039)                                                    DOSE2960
      WRITE(51,9040)  BSUBV2                                            DOSE2965
      WRITE(51,9041)                                                    DOSE2970
      WRITE(51,9042) F1INH                                              DOSE2975
      WRITE(51,9043) F1ING                                              DOSE2980
      WRITE(51,9044) AMAD                                               DOSE2985
      WRITE(51,9045) ISOL                                               DOSE2990
      IF (I1.EQ.0) GO TO 640                                            DOSE2995
      WRITE(51,9046)                                                    DOSE3000
      WRITE(51,9047)                                                    DOSE3005
      WRITE(51,9048)                                                    DOSE3010
      WRITE(51,9049) NAMNUC(I1),F1                                      DOSE3015
      IF (F2.EQ.0.) GO TO 640                                           DOSE3020
      WRITE(51,9050) NAMNUC(I2),F2                                      DOSE3025
      IF (F3.EQ.0.) GO TO 640                                           DOSE3030
      WRITE(51,9050) NAMNUC(I3),F3                                      DOSE3035
      IF (F4.EQ.0.) GO TO 640                                           DOSE3040
      WRITE(51,9050) NAMNUC(I4),F4                                      DOSE3045
      IF (F5.EQ.0.) GO TO 640                                           DOSE3050
      WRITE(51,9050) NAMNUC(I5),F5                                      DOSE3055
640   CONTINUE                                                          DOSE3060
650   CONTINUE                                                          DOSE3065
      WRITE(51,9134)                                                    DOSE3070
      WRITE(51,9135)                                                    DOSE3075
      WRITE(51,9136)                                                    DOSE3080
      WRITE(51,9137)                                                    DOSE3085
      WRITE(51,9072)                                                    DOSE3090
      DO 670 J=1,NUMORG                                                 DOSE3095
         DO 660 K=1,11                                                  DOSE3100
            IF (NAMORG(J).NE.NAMES(K)) GO TO 660                        DOSE3105
            CASBA=CFSBA*FROG(K)                                         DOSE3110
            CASUR=CFSUR*FROG(K)                                         DOSE3115
            CASBW=CFSBW*FROG(K)                                         DOSE3120
            WRITE(51,9138) NAMORG(J),CFINHA(J),CFINGA(J),CASBA,CASUR,   DOSE3125
     >       CASBW                                                      DOSE3130
660         CONTINUE                                                    DOSE3135
670      CONTINUE                                                       DOSE3140
680   CONTINUE                                                          DOSE3145
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C START OF MAXIMIZING CALCULATIONS FOR THE INDIVIDUAL DOSE OPTION       DOSE3150
      IF (LIPO.EQ.1) GO TO 850                                          DOSE3155
      DO 840 J=1,11                                                     DOSE3160
         ADSE=0                                                         DOSE3165
         DO 750 NO=NOL,NOU                                              DOSE3170
            DO 740 NR=NRL,NRU                                           DOSE3175
               DSE=0                                                    DOSE3180
               AKR=0                                                    DOSE3185
               BKR=0                                                    DOSE3190
               DKR=0                                                    DOSE3195
               EKR=0                                                    DOSE3200
               VEG=0                                                    DOSE3205
               BEF=0                                                    DOSE3210
               AME=0                                                    DOSE3215
               DO 730 I=1,NNUCS                                         DOSE3220
                  AC=ACON(I,NOMM(I,J),NRMM(I,J))                        DOSE3225
                  IF (AC.EQ.0.) GO TO 690                               DOSE3230
                  AKR=ORMODI(I,J,1)/AC*ACON(I,NO,NR)+AKR                DOSE3235
                  BKR=ORMODI(I,J,2)/AC*ACON(I,NO,NR)+BKR                DOSE3240
  690             BC=GBUP(I,NOMM(I,J),NRMM(I,J))                        DOSE3245
                  IF (BC.EQ.0) GO TO 700                                DOSE3250
                  DKR=ORMODI(I,J,3)/BC*GBUP(I,NO,NR)+DKR                DOSE3255
                  EKR=ORMODI(I,J,5)/BC*GBUP(I,NO,NR)+EKR                DOSE3260
  700             IF (NAMNUC(I).EQ.NADEC1.OR.NAMNUC(I).EQ.NADEC3) GO TO DOSE3265
     >             710                                                  DOSE3270
                  IF (BC.EQ.0) GO TO 720                                DOSE3275
                  VEG=ORMODI(I,J,6)*(KIQ(I,NO,NR)/(KIQ(I,NOMM(I,J),     DOSE3280
     >             NRMM(I,J))+1.E-60))+VEG                              DOSE3285
                  BEF=ORMODI(I,J,7)*(GFIN(I,NO,NR)/(GFIN(I,NOMM(I,J),   DOSE3290
     >             NRMM(I,J))+1.E-60))+BEF                              DOSE3295
                  AME=ORMODI(I,J,8)*(FING(I,NO,NR)/(FING(I,NOMM(I,J),   DOSE3300
     >             NRMM(I,J))+1.E-60))+AME                              DOSE3305
                  GO TO 720                                             DOSE3310
  710             ACO=ACON(I,NO,NR)                                     DOSE3315
                  VEG=((F1V*ACO+F2V*VAGAC(I))/(F1V*AC+F2V*VAGAC(I)+1.E- DOSE3320
     >             60))* ORMODI(I,J,6)+VEG                              DOSE3325
                  BEF=((F1B*ACO+F2B*BAGAC(I))/(F1B*AC+F2B*BAGAC(I)+1.E- DOSE3330
     >             60))* ORMODI(I,J,7)+BEF                              DOSE3335
                  AME=((F1M*ACO+F2M*MAGAC(I))/(F1M*AC+F2M*MAGAC(I)+1.E- DOSE3340
     >             60))* ORMODI(I,J,8)+AME                              DOSE3345
                  IF (NAMNUC(I).EQ.NADEC1) AME=AME+ACO*TDCWB            DOSE3349
  720             CONTINUE                                              DOSE3350
                  TING=VEG+BEF+AME                                      DOSE3355
  730             DSE=AKR+BKR+DKR+EKR+TING                              DOSE3365
               IF (DSE.LT.ADSE) GO TO 740                               DOSE3370
               ADSE=DSE                                                 DOSE3375
               NOML(J)=NO                                               DOSE3380
               NRML(J)=NR                                               DOSE3385
  740          CONTINUE                                                 DOSE3390
  750       CONTINUE                                                    DOSE3395
         NO=NOML(J)                                                     DOSE3400
         NR=NRML(J)                                                     DOSE3405
         DO 830 I=1,NNUCS                                               DOSE3410
            AC=ACON(I,NOMM(I,J),NRMM(I,J))                              DOSE3415
      IF (AC.EQ.0.) GO TO 760                                           DOSE3419
            ACI=ACON(I,NO,NR)                                           DOSE3420
            IF (ACI.EQ.0.) GO TO 760                                    DOSE3425
            ORMODI(I,J,1)=ORMODI(I,J,1)/AC*ACI                          DOSE3430
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                 ORMODI(I,J,2)=ORMODI(I,J,2)/AC*ACI                            DOSE3435
                 GO TO 770                                                     DOSE3440
 760             ORMODI(I,J,1)=0.                                              DOSE3445
                 ORMODI(I,J,2)=0.                                              DOSE3450
 770             BC=GBUP(I,NOMM(I,J),NRMM(I,J))                                DOSE3455
           IF (BC.EQ.0.) GO TO 780                                             DOSE3459
                 BCI=GBUP(I,NO,NR)                                             DOSE3460
                 IF (BCI.EQ.0) GO TO 780                                       DOSE3465
                 ORMODI(I,J,3)=ORMODI(I,J,3)/BC*BCI                            DOSE3470
                 ORMODI(I,J,5)=ORMODI(I,J,5)/BC*BCI                            DOSE3475
                 GO TO 790                                                     DOSE3480
 780             ORMODI(I,J,3)=0                                               DOSE3485
                 ORMODI(I,J,5)=0                                               DOSE3490
 790             IF (NAMNUC(I).EQ.NADEC1.OR.NAMNUC(I).EQ.NADEC3) GO TO 810     DOSE3495
                 IF (BCI.EQ.0) GO TO 800                                       DOSE3500
                 ORMODI(I,J,6)=ORMODI(I,J,6)*(KIQ(I,NO,NR)/(KIQ(I,NOMM(I,J),   DOSE3505
     >            NRMM(I,J))+1.E-60))                                          DOSE3510
                 ORMODI(I,J,7)=ORMODI(I,J,7)*(GFIN(I,NO,NR)/(GFIN(I,NOMM(I,J)  DOSE3515
     >            ,NRMM(I,J))+1.E-60))                                         DOSE3520
                 ORMODI(I,J,8)=ORMODI(I,J,8)*(FING(I,NO,NR)/(FING(I,NOMM(I,J)  DOSE3525
     >            ,NRMM(I,J))+1.E-60))                                         DOSE3530
                 GO TO 820                                                     DOSE3535
 800             ORMODI(I,J,6)=0                                               DOSE3540
                 ORMODI(I,J,7)=0                                               DOSE3545
                 ORMODI(I,J,8)=0                                               DOSE3550
                 GO TO 820                                                     DOSE3555
 810             CONTINUE                                                      DOSE3560
                 ORMODI(I,J,6)=((F1V*ACI+F2V*VAGAC(I))/(F1V*AC+F2V*VAGAC(I)+   DOSE3565
     >             1.E-60) )* ORMODI(I,J,6)                                    DOSE3570
                 ORMODI(I,J,7)=((F1B*ACI+F2B*BAGAC(I))/(F1B*AC+F2B*BAGAC(I)+   DOSE3575
     >             1.E-60) )* ORMODI(I,J,7)                                    DOSE3580
                 ORMODI(I,J,8)=((F1M*ACI+F2M*MAGAC(I))/(F1M*AC+F2M*MAGAC(I)+   DOSE3585
     >             1.E-60) )* ORMODI(I,J,8)                                    DOSE3590
 820             ORMODI(I,J,4)=ORMODI(I,J,6)+ORMODI(I,J,7)+ORMODI(I,J,8)       DOSE3595
                 IF (NAMNUC(I).EQ.NADEC1) ORMODI(I,J,4)=ORMODI(I,J,4)+ACI*     DOSE3600
     >            TDCWB                                                        DOSE3605
 830             CONTINUE                                                      DOSE3610
 840          CONTINUE                                                         DOSE3615
C END OF MAXIMIZING CALCULATIONS FOR THE INDIVIDUAL DOSE OPTION                  DOSE3620
 850       IF (NRTB.EQ.0) GO TO 880                                            DOSE3625
           DO 870 I=1,NNUCS                                                    DOSE3630
              PUNCH 9139,NAMNUC(I)                                             DOSE3635
              DO 860 MD=1,8                                                    DOSE3640
                 PUNCH 9140,(ORMODI(I,J,MD),J=1,11)                            DOSE3645
 860             CONTINUE                                                      DOSE3650
 870          CONTINUE                                                         DOSE3655
 880       CONTINUE                                                            DOSE3660
C    OUTPUT FOR HEALTH RISK CALCULATIONS                                        DOSE3665
           IF (NSTB.EQ.0) GO TO 980                                            DOSE3670
           IF (FEQWL.EQ.0.) FEQWL=0.7                                          DOSE3675
           DO 970 I=1,NNUCS                                                    DOSE3680
              TIME=0                                                           DOSE3685
              WRITE(25)NAMNUC(I),PARSIZ(I),CLASS(I),(GI(I,J),J=1,4),TIME,LIPO  DOSE3690
              WRITE(25)NOL,NOU,NRL,NRU,(IDIST(IG),IG=NRL,NRU)                  DOSE3695
              IF (LIPO.EQ.1) GO TO 890                                         DOSE3700
              WRITE(51,9051)NAMNUC(I)                                          DOSE3705
              GO TO 900                                                        DOSE3710
 890          WRITE(51,9052)NAMNUC(I)                                          DOSE3715
 900    CONTINUE
        WRITE(51,9053)
        IF (LIPO.EQ.1) GO TO 910
        WRITE(51,9054)
        GO TO 920
 910    WRITE(51,9055)
 920    WRITE(51,9056)
        WRITE(51,9057)
        WRITE(51,9058)
        ALIP=LIPO
        DO 960 NO=NOL,NOU
           DO 950 NR=NRL,NRU
              ACUP=ACON(I,NO,NR)*1.E-6*(ALIP*(INTPA(NO,NR)-1.)+1.)
              GBIP=GBUP(I,NO,NR)*(ALIP*(INTPA(NO,NR)-1.)+1.)
              FIOP=(KIQ(I,NO,NR)+GFIN(I,NO,NR)+FING(I,NO,NR))* (ALIP*
    >          (INTPA(NO,NR)-1.)+1.)
              FINH=ACON(I,NO,NR)*BRTHRT*8760.*(ALIP*(INTPA(NO,NR)-1.)+
    >          1.)
              WRITE(51,9059) NO,IDIST(NR),ACUP,GBIP,FIOP,FINH
              IF (NAMNUC(I).EQ.NADRN) GO TO 930
              WRITE(25) ACUP,GBIP,FIOP,FINH
              GO TO 940
930        WAL=FEQWL*10.*ACON(I,NO,NR)*(ALIP*(INTPA(NO,NR)-1.)+1.)
              WRITE(25) FEQWL,WAL
 940          CONTINUE
 950          CONTINUE
 960       CONTINUE
        WRITE(51,9060)
        IF(LIPO.EQ.1) WRITE(25) INTPA
 970    CONTINUE
 980 CONTINUE
     CALL DOSMIC(NTTB,NUTB)
990  RETURN
9000 FORMAT(8E10.3)
9001 FORMAT('1',T42,
    > 'OPTIONS SELECTED FOR DOSE AND INTAKE CALCULATIONS')
9002 FORMAT('0',T20,'CALCULATIONS ARE MADE FOR THE MAXIMALLY-EXPOSED IN
    >DIVIDUAL.')
9003 FORMAT('0',T20,'CALCULATIONS ARE MADE FOR THE POPULATION.')
9004 FORMAT(' ',T20,'TABLES FOR EACH NUCLIDE LISTING DOSES BY ORGAN AND
    > PATHWAY AT EACH ENVIRONMENTAL LOCATION ARE OMITTED.')
9005 FORMAT(' ',T20,'TABLES LISTING DOSES BY ORGAN AND PATHWAY AT EACH
    >ENVIRONMENTAL LOCATION ARE PRINTED FOR ',I2,' NUCLIDES')
9006 FORMAT(' ',T20,'DOSES BY NUCLIDE,ORGAN, AND PATHWAY ARE PUNCHED ON
    > CARDS')
9007 FORMAT(' ',T20,'ENVIRONMENTAL CONCENTRATIONS AND INTAKE RATES BY M
    >AN FOR EACH NUCLIDE ARE PRINTED AND WRITTEN UNFORMATTED.')
9008 FORMAT(' ',T20,'DOSE SUMMARY TABLES ARE PRINTED')
9009 FORMAT(' ',T20,'WORKING LEVELS ARE CALCULATED FOR RN-222 IF IT IS
    >IN THE SOURCE TERM')
9010 FORMAT('0',T13,'EFFECTIVE SURFACE DENSITY OF SOIL (KG/SQ. M, DRY',
    > ' WEIGHT) (ASSUMES 15 CM PLOW LAYER)',T110,E12.4)
9011 FORMAT('0',T13,'PERIOD OF LONG-TERM BUILDUP FOR ',
    > 'ACTIVITY IN SOIL (YEARS)',T110,E12.4)
9012 FORMAT('0',T13,'TIME DELAY--INGESTION OF PASTURE GRASS BY ',
    > 'ANIMALS (HR)',T110,E12.4)
9013 FORMAT('0',T13,'TIME DELAY--INGESTION OF STORED FEED BY ',
    > 'ANIMALS (HR)',T110,E12.4)
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9014 FORMAT('0',T13,'TIME DELAY--INGESTION OF LEAFY VEGETABLES ',        DOSE4010
    > 'BY MAN (HR)' ,T110,E12.4)                                          DOSE4015
9015 FORMAT('0',T13,'TIME DELAY--INGESTION OF PRODUCE BY ', 'MAN (HR)',DOSE4020
    > T110,E12.4)                                                         DOSE4025
9016 FORMAT('0',T13,'REMOVAL RATE CONSTANT FOR PHYSICAL LOSS BY ',        DOSE4030
    > 'WEATHERING (PER HOUR)',T110,E12.4)                                 DOSE4035
9017 FORMAT('0',T13,'PERIOD OF EXPOSURE DURING GROWING SEASON--',         DOSE4040
    > 'PASTURE GRASS (HR)',T110,E12.4)                                    DOSE4045
9018 FORMAT('0',T13,'PERIOD OF EXPOSURE DURING GROWING SEASON--',         DOSE4050
    > 'CROPS OR LEAFY VEGETABLES (HR)',T110,E12.4)                        DOSE4055
9019 FORMAT('0',T13,'AGRICULTURAL PRODUCTIVITY BY UNIT AREA ',            DOSE4060
    > '(GRASS-COW-MILK-MAN PATHWAY (KG/SQ. METER))',T110,E12.4)           DOSE4065
9020 FORMAT('0',T13,'AGRICULTURAL PRODUCTIVITY BY UNIT AREA ',            DOSE4070
    > '(PRODUCE OR LEAFY VEG INGESTED BY MAN (KG/SQ. METER))',T110,       DOSE4075
    > E12.4)                                                              DOSE4080
9021 FORMAT('0',T13,'FRACTION OF YEAR ANIMALS GRAZE ON PASTURE ', T110,DOSE4085
    > E12.4)                                                              DOSE4090
9022 FORMAT('0',T13,'FRACTION OF DAILY FEED THAT IS PASTURE GRASS ',      DOSE4095
    > 'WHEN ANIMAL GRAZES ON PASTURE',T110,E12.4)                         DOSE4100
9023 FORMAT('0',T13,'CONSUMPTION RATE OF CONTAMINATED FEED OR FORAGE ',DOSE4105
    >  'BY AN ANIMAL IN KG/DAY (DRY WEIGHT)',T110,E12.4)                  DOSE4110
9024 FORMAT('0',T13,'TRANSPORT TIME FROM ANIMAL FEED-MILK-MAN (DAY)',     DOSE4115
    > T110,E12.4)                                                         DOSE4120
9025 FORMAT('0',T13,'RATE OF INGESTION OF PRODUCE BY MAN (KG/YR)',        DOSE4125
    > T110,E12.4)                                                         DOSE4130
9026 FORMAT('0',T13,'RATE OF INGESTION OF MILK BY MAN (LITERS/YR)',       DOSE4135
    > T110,E12.4)                                                         DOSE4140
9027 FORMAT('0',T13,'RATE OF INGESTION OF MEAT BY MAN (KG/YR)', T110,     DOSE4145
    > E12.4)                                                              DOSE4150
9028 FORMAT('0',T13,'RATE OF INGESTION OF LEAFY VEGETABLES BY MAN ',      DOSE4155
    > '(KG/YR)',T110,E12.4)                                               DOSE4160
9029 FORMAT('0',T13,'AVERAGE TIME FROM SLAUGHTER OF MEAT ANIMAL TO ',     DOSE4165
    > 'CONSUMPTION (DAY)',T110,E12.4)                                     DOSE4170
9030 FORMAT('0',T13,'FRACTION OF PRODUCE INGESTED GROWN IN GARDEN ',      DOSE4175
    > 'OF INTEREST',T110,E12.4)                                           DOSE4180
9031 FORMAT('0',T13,'FRACTION OF LEAFY VEGETABLES GROWN IN GARDEN ',      DOSE4185
    > 'OF INTEREST',T110,E12.4)                                           DOSE4190
9032 FORMAT(5I4,5E10.3)                                                   DOSE4195
9033 FORMAT(T11,A1,T15,E10.3,T27,E10.3)                                   DOSE4200
9034 FORMAT(A8,T10,E10.3)                                                 DOSE4205
9035 FORMAT(T11,E10.3)                                                    DOSE4210
9036 FORMAT('0',T13,'AVERAGE FRACTION OF ANIMAL''S DAILY INTAKE ',        DOSE4215
    > 'OF NUCLIDE WHICH APPEARS IN EACH L OF MILK (DAYS/L)', T110,        DOSE4220
    > E12.4)                                                              DOSE4225
9037 FORMAT('0',T13,'FRACTION OF ANIMAL''S DAILY INTAKE OF NUCLIDE ',     DOSE4230
    > 'WHICH APPEARS IN EACH KG OF FLESH (DAYS/KG)',T110,E12.4)           DOSE4235
9038 FORMAT('0',T13,'CONCENTRATION FACTOR FOR UPTAKE OF NUCLIDE FROM SODOSE4240
    >IL FOR PASTURE AND FORAGE',T110,E12.4)                               DOSE4245
9039 FORMAT(' ',T20,'(IN PCI/KG DRY WEIGHT PER PCI/KG DRY SOIL)')         DOSE4250
9040 FORMAT('0',T13,'CONCENTRATION FACTOR FOR UPTAKE OF NUCLIDE FROM SODOSE4255
    >IL BY EDIBLE PARTS OF CROPS',T110,E12.4)                             DOSE4260
9041 FORMAT(' ',T20,'(IN PCI/KG WET WEIGHT PER PCI/KG DRY SOIL)')         DOSE4265
9042 FORMAT('0',T13,'GI UPTAKE FRACTION (INHALATION)',T110,E12.4)         DOSE4270
9043 FORMAT('0',T13,'GI UPTAKE FRACTION (INGESTION)' ,T110,E12.4)         DOSE4275
9044 FORMAT('0',T13,'PARTICLE SIZE (MICRONS)',T110,E12.4)                 DOSE4280
9045 FORMAT('0',T13,'SOLUBILITY CLASS',T110,A1)                           DOSE4285
9046 FORMAT('0',T20,'CONCENTRATIONS ON GROUND AND WATER INCLUDE CONTRIBDOSE4290
    >UTIONS RESULTING FROM ')                                             DOSE4295
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9047 FORMAT(' ',T20,'DECAY OF THE FOLLOWING PARENT NUCLIDES AFTER DEPOSDOSE4300
     >ITION--')                                                         DOSE4305
9048 FORMAT('0',T40,'NUCLIDE',T67,'BUILDUP FACTOR')                     DOSE4310
9049 FORMAT('0',T41,A8,T69,E10.3)                                       DOSE4315
9050 FORMAT(' ',T41,A8,T69,E10.3)                                       DOSE4320
9051 FORMAT('1',T45,'CONCENTRATIONS AND INTAKE RATES FOR ',A8)          DOSE4325
9052 FORMAT('1',T30,'POPULATION-WEIGHTED CONCENTRATIONS AND POPULATION  DOSE4330
     >INTAKES FOR ',A8)                                                 DOSE4335
9053 FORMAT('0',T10,'AREA',T42,'AIR CONCENTRATION',T63,                 DOSE4340
     > 'GROUND CONCENTRATION',T89,'INGESTION INTAKE',T114,              DOSE4345
     > 'INHALATION INTAKE')                                             DOSE4350
9054 FORMAT(' ',T41,'(CURIES/CUBIC METER)',T63,'(CURIES/SQUARE METER)', DOSE4355
     > T92,'(PCI/YEAR)',T117,'(PCI/YEAR)')                              DOSE4360
9055 FORMAT(' ',T38,'(MAN-CURIES/CUBIC METER)',T62,                     DOSE4365
     > '(MAN-CURIES/SQUARE METER)',T90,'(MAN-PCI/YEAR)',T115,           DOSE4370
     > '(MAN-PCI/YEAR)')                                                DOSE4375
9056 FORMAT(' ',T3,'DIRECTION',T19,'DISTANCE')                          DOSE4380
9057 FORMAT(' ',T19,'(METERS)')                                         DOSE4385
9058 FORMAT('0')                                                        DOSE4390
9059 FORMAT(' ',T6,I2,T18,I7,T45,E10.3,T68,E10.3,T92,E10.3,T118,E10.3)  DOSE4395
9060 FORMAT('0',T10,'DIRECTIONS ARE NUMBERED COUNTERCLOCKWISE STARTING  DOSE4400
     >AT 1 FOR DUE NORTH')                                              DOSE4405
9061 FORMAT(5I10)                                                       DOSE4410
9062 FORMAT(16I5)                                                       DOSE4415
9063 FORMAT(16I5)                                                       DOSE4420
9064 FORMAT(8E10.3)                                                     DOSE4425
9065 FORMAT(8F10.1)                                                     DOSE4430
9066 FORMAT(40I2)                                                       DOSE4435
9067 FORMAT(I10)                                                        DOSE4440
9068 FORMAT(6F10.3)                                                     DOSE4445
9069 FORMAT(6F10.3)                                                     DOSE4450
9070 FORMAT (10F8.4)                                                    DOSE4455
9071 FORMAT('1')                                                        DOSE4460
9072 FORMAT('0')                                                        DOSE4465
9073 FORMAT('0',T48,'SUMMARY OF AREA SURROUNDING PLANT')                DOSE4470
9074 FORMAT('0',T20,'AREA',T40,'NO. MEAT ANIMALS',T60,                  DOSE4475
     > 'NO. MILK CATTLE' ,T80,'FOOD CROPS',T95,'WATER AREA',T113,       DOSE4480
     > 'POPULATION')                                                    DOSE4485
9075 FORMAT(' ',T78,'(SQUARE METERS)')                                  DOSE4490
9076 FORMAT('0',T16,'COLUMN',T26,'ROW')                                 DOSE4495
9077 FORMAT(' ',T18,I2,T27,I2,T45,I5,T64,I5,T78,E10.3,T100,I2,T110,     DOSE4500
     > F10.1)                                                           DOSE4505
9078 FORMAT(' ',T20,'FOR WATER AREAS--0= NONE OR MINIMAL AND 1= MAJOR WDOSE4510
     >ATER AREA PRESENT')                                               DOSE4515
9079 FORMAT('1',T36,'LIST OF INPUT VALUES FOR RADIONUCLIDE-INDEPENDENT DOSE4520
     >VARIABLES')                                                       DOSE4525
9080 FORMAT('0',T13,'NUMBER OF NUCLIDES CONSIDERED',T110,I12)           DOSE4530
9081 FORMAT('0',T13,'VEGETABLE INGESTION RATIO-IMMEDIATE SURROUNDING ARDOSE4535
     >EA/TOTAL WITHIN AREA',T110,E12.4)                                 DOSE4540
9082 FORMAT('0',T13,'MEAT INGESTION RATIO-IMMEDIATE SURROUNDING AREA/TODOSE4545
     >TAL WITHIN AREA',T110,E12.4)                                      DOSE4550
9083 FORMAT('0',T13,'MILK INGESTION RATIO-IMMEDIATE SURROUNDING AREA/TODOSE4555
     >TAL WITHIN AREA',T110,E12.4)                                      DOSE4560
9084 FORMAT(' ',T25,'MINIMUM FRACTIONS OF FOOD TYPES FROM OUTSIDE AREA DOSE4565
     >LISTED BELOW ARE ACTUAL FIXED VALUES')                            DOSE4570
9085 FORMAT(' ',T25,'ACTUAL FRACTIONS OF FOOD TYPES FROM OUTSIDE AREA CDOSE4575
     >AN BE GREATER THAN THE MINIMUM FRACTIONS LISTED BELOW')           DOSE4580
9086 FORMAT('0',T13,                                                    DOSE4585
      > 'MINIMUM FRACTION VEGETABLES INGESTED FROM OUTSIDE AREA',T110,   DOSE4590
      > E12.4)                                                           DOSE4595
 9087 FORMAT('0',T13,'MINIMUM FRACTION MEAT INGESTED FROM OUTSIDE AREA',DOSE4600
      >  T110,E12.4)                                                     DOSE4605
 9088 FORMAT('0',T13,'MINIMUM FRACTION MILK INGESTED FROM OUTSIDE AREA',DOSE4610
      >  T110,E12.4)                                                     DOSE4615
 9089 FORMAT('0',T13,'INHALATION RATE OF MAN (CUBIC CENTIMETERS/HR)',   DOSE4620
      > T110,E12.4)                                                      DOSE4625
 9090 FORMAT('0',T13,'BUILDUP TIME FOR RADIONUCLIDES DEPOSITED ON GROUNDDOSE4630
      > AND WATER (DAYS)',T110,E12.4)                                    DOSE4635
 9091 FORMAT('0',T13,'DILUTION FACTOR FOR WATER FOR SWIMMING (CM)',T110,DOSE4640
      >  E12.4)                                                          DOSE4645
 9092 FORMAT('0',T13,'FRACTION OF TIME SPENT SWIMMING',T110,E12.4)      DOSE4650
 9093 FORMAT('0',T13,'MUSCLE MASS OF ANIMAL AT SLAUGHTER (KG)',T110,    DOSE4655
      > E12.4)                                                           DOSE4660
 9094 FORMAT('0',T13,'FALLOUT INTERCEPTION FRACTION-VEGETABLES', T110,   DOSE4665
      > E12.4)                                                           DOSE4670
 9095 FORMAT('0',T13,'FALLOUT INTERCEPTION FRACTION-PASTURE',T110,E12.4) DOSE4675
 9096 FORMAT('0',T13,'FRACTION OF ANIMAL HERD SLAUGHTERED PER DAY',T110,DOSE4680
      >  E12.4)                                                          DOSE4685
 9097 FORMAT('0',T13,'MILK PRODUCTION OF COW (LITERS/DAY)',T110,E12.4)  DOSE4690
 9098 FORMAT('0',T13,'FRACTION OF RADIOACTIVITY RETAINED ON LEAFY VEGETADOSE4695
      >BLES AND PRODUCE AFTER WASHING',T110,E12.4)                       DOSE4700
 9099 FORMAT('1',T51,'COMPUTED VALUES FOR THE AREA')                     DOSE4705
 9100 FORMAT('0',T13,'TOTAL POPULATION',T110,F12.1)                      DOSE4710
 9101 FORMAT('0',T13,'TOTAL NUMBER OF MEAT ANIMALS',T110,I12)            DOSE4715
 9102 FORMAT('0',T13,'TOTAL NUMBER OF MILK CATTLE',T110,I12)             DOSE4720
 9103 FORMAT('0',T13,                                                    DOSE4725
      > 'TOTAL AREA OF VEGETABLE FOOD CROPS (SQUARE METERS)',T110,E12.4) DOSE4730
 9104 FORMAT('0',T13,'TOTAL MEAT CONSUMPTION (KG PER YEAR)',T110,E12.4) DOSE4735
 9105 FORMAT('0',T13,'TOTAL MEAT PRODUCTION (KG PER YEAR)',T110,E12.4)  DOSE4740
 9106 FORMAT('0',T13,'TOTAL MILK CONSUMPTION (LITERS/YEAR)',T110,E12.4) DOSE4745
 9107 FORMAT('0',T13,'TOTAL MILK PRODUCTION (LITERS/YEAR)',T110,E12.4)  DOSE4750
 9108 FORMAT('0',T13,'TOTAL VEGETABLE FOOD CONSUMPTION (KG PER YEAR)',  DOSE4755
      > T110,E12.4)                                                      DOSE4760
 9109 FORMAT('0',T13,'TOTAL VEGETABLE FOOD PRODUCED (KG PER YEAR)',T110,DOSE4765
      >  E12.4)                                                          DOSE4770
 9110 FORMAT(I10,4E10.3,I10,2E10.3)                                      DOSE4775
 9111 FORMAT(11F5.3)                                                     DOSE4780
 9112 FORMAT (2E10.3,I1,6F8.4)                                           DOSE4785
 9113 FORMAT('1',T42,'RESULTS OF DOSE COMPUTATIONS FOR NUCLIDE ',A8)     DOSE4790
 9114 FORMAT('0',T15,'AREA',T26,'ORGAN',T60,                             DOSE4795
      > 'DOSE THROUGH EACH PATHWAY (REMS/YEAR)')                         DOSE4800
 9115 FORMAT('0',T11,'COLUMN',T20,'ROW')                                 DOSE4805
 9116 FORMAT('0',T40,'INHALATION',T55,'SUBMERSION',T70,'SURFACE',T85,    DOSE4810
      > 'INGESTION',T100,'SUBMERSION',T117,'TOTAL')                      DOSE4815
 9117 FORMAT(' ',T57,'IN AIR',T69,'EXPOSURE',T102,'IN WATER')            DOSE4820
 9118 FORMAT(' ',T13,I2,T20,I2,T25,A8,T40,E10.3,T55,E10.3,T70,E10.3,T85, DOSE4825
      >  E10.3,T100,E10.3,T115,E10.3)                                    DOSE4830
 9119 FORMAT('1',T47,'LIST OF INPUT DATA FOR NUCLIDE ',A8)               DOSE4835
 9120 FORMAT('0',T13,'FLAG ERROR')                                       DOSE4840
 9121 FORMAT('0',T13,'FALLOUT INTERCEPTION FRACTION-VEGETABLES', T110,   DOSE4845
      > E12.4)                                                           DOSE4850
 9122 FORMAT('0',T13,'FALLOUT INTERCEPTION FRACTION-PASTURE',T110,E12.4) DOSE4855
 9123 FORMAT ('0',T13, 'FALLOUT INTERCEPTION FRACTION(DRY)-VEGETABLES',  DOSE4860
      > T110, E12.4)                                                     DOSE4865
 9124 FORMAT ('0',T13, 'FALLOUT INTERCEPTION FRACTION(WET)-VEGETABLES',  DOSE4870
      > T110, E12.4)                                                     DOSE4875
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9125 FORMAT('0',T13,'FALLOUT INTERCEPTION FRACTION(DRY)-PASTURE', T110,DOSE4880
    > E12.4)                                                           DOSE4885
9126 FORMAT('0',T13,'FALLOUT INTERCEPTION FRACTION(WET)-PASTURE', T110,DOSE4890
    > E12.4)                                                           DOSE4895
9127 FORMAT('0',T13,'RADIOACTIVE DECAY CONSTANT (PER DAY)',T110,E12.4) DOSE4900
9128 FORMAT('0',T25,'RADIOACTIVE DECAY FOR SURFACE EXPOSURE AND FOR WATDOSE4905
    >ER IMMERSION PROCEEDS IN ACCORDANCE WITH THE')                    DOSE4910
9129 FORMAT(' ',T25,'EFFECTIVE DECAY CONSTANT IN THE PLUME INSTEAD OF TDOSE4915
    >HE ABOVE VALUE')                                                  DOSE4920
9130 FORMAT('0',T13,'ENVIRONMENTAL DECAY CONSTANT--SURFACE (PER DAY)', DOSE4925
    > T110,E12.4)                                                      DOSE4930
9131 FORMAT('0',T13,'ENVIRONMENTAL DECAY CONSTANT--WATER (PER DAY)',   DOSE4935
    > T110,E12.4)                                                      DOSE4940
9132 FORMAT('0',T13,'DOSE CONVERSION FACTOR FOR FOOD INGESTION (REM-CC/DOSE4945
    >PCI-YEAR)',T110,E12.4)                                            DOSE4950
9133 FORMAT('0',T13,'DOSE CONVERSION FACTOR FOR WATER INGESTION (REM-CCDOSE4955
    >/PCI-YEAR)',T110,E12.4)                                           DOSE4960
9134 FORMAT('0',T55,'DOSE CONVERSION FACTORS')                         DOSE4965
9135 FORMAT('0',T5,'ORGAN',T20,'INHALATION',T38,'INGESTION',T58,       DOSE4970
    > 'SUBMERSION IN AIR',T83,'SURFACE EXPOSURE',T107,                 DOSE4975
    > 'SUBMERSION IN WATER')                                           DOSE4980
9136 FORMAT(' ',T17,'(REMS/MICROCURIE)',T34,'(REMS/MICROCURIE)',T59,   DOSE4985
    > '(REMS-CUBIC CM/',T83,'(REMS-SQUARE CM/',T109,'(REMS-CUBIC CM/') DOSE4990
9137 FORMAT(' ',T60,'MICROCURIE-HR)',T84,'MICROCURIE-HR)',T110,        DOSE4995
    > 'MICROCURIE-HR)')                                                DOSE5000
9138 FORMAT(' ',T4,A8,T21,E10.3,T38,E10.3,T61,E10.3,T86,E10.3,T111,    DOSE5005
    > E10.3)                                                           DOSE5010
9139 FORMAT(A8)                                                        DOSE5015
9140 FORMAT(6E10.4)                                                    DOSE5020
      END                                                              DOSE5025
      FUNCTION CV(I,LAMI,DEPRAT,GCRU,TSUBE,YSUBV,TSUBH,R)
C CALCULATES THE CONCENTRATION OF NUCLIDE I IN AND ON VEGETATION USING
C EQ C-5, REG GUIDE 1.109-25. THE INPUT PARAMETERS ARE DEFINED AS FOLLOW
C
C      I          INDEXES NUCLIDE
C      LAMI       RADIOACTIVE DECAY CONSTANT FOR THE NUCLIDE  (HR**-1)
C      DEPRAT     DEPOSITION RATE OF RADIONUCLIDE I ONTO GROUND
C                 AT THE GIVEN LOCATION ( PCI /M**2-HR)
C      TSUBE      PERIOD OF CROP, LEAFY VEGETABLE, OR PASTURE GRASS EXPOSU
C                 DURING GROWING SEASON (HR)
C      YSUBV      AGRICULTURAL PRODUCTIVITY BY UNIT AREA (MEASURED IN WET
C                 WEIGHT)  (KG/M**2)
C      TSUBH      TIME DELAY BETWEEN HARVEST OF VEGETATION OR CROPS AND
C                 INGESTION (HR)
C      R          FRACTION OF DEPOSITED ACTIVITY RETAINED
C                 ON CROPS, DIMENSIONLESS
C
      REAL LAMEI,LAMI,LAMRR,LAMW
      COMMON /INGDOS/LAMW,TSUBB,P,BSUBV,DR,RATUA
      COMMON /OCOM/ NAMNUC(36),WORD,NNUCS,ANLAM(36),RR,SQSD,ACON(36,20,
     > 20),GCON(36,20,20),LIPO,NOMM(36,11),NRMM(36,11),ORMODI(36,12,8),
     > VD(36),VDCOEF(20,20),NOL,NOU,NRL,NRU
      REAL*8 NAMNUC,WORD
C THE EFFECTIVE REMOVAL RATE CONSTANT FOR THE RADIONUCLIDE FROM CROPS
C IN HR**-1 IS  (REG GUIDE 1.109-4)
      LAMEI = LAMI + LAMW
C WHERE LAMW IS THE REMOVAL RATE CONSTANT FOR WEATHERING.
C
C THE FOLLOWING CODE CALCULATES CV= CONCENTRATION OF NUCLIDE I USING EQ
      STUBB=TSUBB*8760.
      ALT=LAMEI*TSUBE
      IF (ALT.GT.0.03) GO TO 10
      XNUD1=(R*DR/YSUBV)*((0.1666667*ALT-0.5)*ALT+TSUBE)
      GO TO 20
   10 XNUD1=(R*DR/YSUBV)*((1.0-EXP(-LAMEI*TSUBE))/LAMEI)
   20 CONTINUE
      ALT=LAMI*STUBB
      IF (ALT.GT.0.03) GO TO 30
      XNUD2=(BSUBV/P)*((0.1666667*ALT-0.5)*ALT+STUBB)
      GO TO 40
   30 XNUD2=(BSUBV/P)*((1.0-EXP(-LAMI*STUBB))/LAMI)
   40 CONTINUE
      SUM=XNUD1+XNUD2
      PROD=SUM*EXP(-LAMI*TSUBH)
      SUM2=XNUD2
      PROD2=SUM2*EXP(-LAMI*TSUBH)
      RATUA=SUM2/SUM
      CV = GCRU * PROD + (DEPRAT-GCRU)*PROD2
      RETURN
      END
      SUBROUTINE RVALUE (IFLAG,MODE,I,NO,NR,R)
      COMMON /RVAL/ S1,S3,SD1,SD3,ACN,GCN,SW1,SW3
      COMMON /OCOM/ NAMNUC(36),WORD,NNUCS,ANLAM(36),RR,SQSD,ACON(36,20,
     > 20),GCON(36,20,20),LIPO,NOMM(36,11),NRMM(36,11),ORMODI(36,12,8),
     > VD(36),VDCOEF(20,20),NOL,NOU,NRL,NRU
      REAL*8 NAMNUC,WORD
C THIS SUBROUTINE ASSIGNS A VALUE TO THE PARAMETER
C     R = THE FRACTION OF DEPOSITED ACTIVITY RETAINED ON CROPS (DIMENSION
C AS FOLLOWS..
C (1)  IF THE VALUES USED FOR S1 AND S3 ARE NOT NUCLIDE-SPECIFIC (NORMAL
C      IFLAG=0), THEN
C            R = S1 FOR VEGETABLES (MODE=1)
C            R = S3 FOR PASTURE    (MODE=2)
C (2)  IF VALUES FOR S1 AND S3 ARE NUCLIDE-SPECIFIC, AND DEPOSITION RATES
C      ARE NOT SPECIFIED SEPARATELY FOR WET AND DRY DEPOSITION (SPECIAL R
C      IFLAG=1), THEN
C            R = SD1 FOR VEGETABLES (MODE=1)
C            R = SD3 FOR PASTURE    (MODE=2)
C (3)  IF VALUES FOR S1 AND S3 ARE NUCLIDE-SPECIFIC, AND DEPOSITION RATES
C      ARE SPECIFIED SEPARATELY FOR WET AND DRY DEPOSITION (IFLAG=2), THE
C      R IS CALCULATED BY AVERAGING DRY AND WET DEPOSITION RATES AS FOLLO
C
C      R =(SD1*DRY DEP RATE  +  SW1*WET DEP RATE) /(DRY DEP RATE+WET DEP
C    FOR VEGETABLES (MODE = 1).
C
C R=(SD3*DRY DEP RATE + SW3*WET DEP RATE)/ (DRY DEP RATE + WET DEP RATE)
C    FOR PASTURE (MODE = 2)
       IF (IFLAG.EQ.0.AND.MODE.EQ.1) R=S1
       IF (IFLAG.EQ.0.AND.MODE.EQ.2) R=S3
       IF (IFLAG.EQ.1.AND.MODE.EQ.1) R=SD1
       IF (IFLAG.EQ.1.AND.MODE.EQ.2) R=SD3
C CALCULATE DRY AND WET DEPOSITION RATES.
       DRYDEP = ACN*VD(I)*VDCOEF(NO,NR)
       WETDEP = GCN - DRYDEP
C THE SUM OF THESE DEPOSITION RATES IS GIVEN BY GCN.
       IF (IFLAG.EQ.2.AND.MODE.EQ.1) R= (SD1*DRYDEP+SW1*WETDEP)/ GCN
       IF (IFLAG.EQ.2.AND.MODE.EQ.2) R= (SD3*DRYDEP+SW3*WETDEP)/ GCN
C PRINT ERROR MESSAGE IF NONE OF THESE CONDITIONS IS MET.
       IF (MODE.NE.1.AND.MODE.NE.2) WRITE(51,9000)
       IF (IFLAG.NE.0.AND.IFLAG.NE.1.AND.IFLAG.NE.2) WRITE(51,9001)
       RETURN
 9000  FORMAT('0ERROR.. MODE SHOULD BE 1 OR 2 IN SUBROUTINE RVALUE')
 9001  FORMAT('0ERROR.. IFLAG SHOULD BE 0,1,OR 2 IN SUBROUTINE RVALUE')
       END
      SUBROUTINE DOSMIC(NNTB,NUTB)
C
      COMMON /OCOM/ NAMNUC(36),WORD,NNUCS,ANLAM(36),RR,SQSD, ACON(36,20,
     >  20),GCON(36,20,20),LIPO,NOMM(36,11),NRMM(36,11), ORMODI(36,12,8)
     > , VD(36),VDCOEF(20,20),NOL,NOU,NRL,NRU
      COMMON NOML(11),NRML(11)
      COMMON /PCOM/ REL(6,36),IDIST(20),NUMST
      COMMON /FCOM/ FEQWL,INTPA(20,20)
      REAL INTPA
      DIMENSION DOSE(12),PTIJ(36,11),TOTJM(11,8),PTOJM(11,8),TOTJ(11),
     > TIJ(36,11),PCT(8),WL(20,20)
      REAL*8 NAMNUC,MODE(8),NAMES(11),WORD,FLAG(8)
      REAL*8 NADRN
      DATA NADRN/'RN-222  '/
      DATA FLAG/' ',' ',' ',' ',' ','*','*','*'/
      DATA NAMES/'TOT.BODY','R MAR   ','LUNGS   ','ENDOST  ','S WALL  ',
     > 'LLI WALL','THYROID ','LIVER   ','KIDNEYS ','TESTES  ',
     > 'OVARIES '/
      DATA MODE/'SUBM AIR','SURFACE ','SWIMMING','INHAL.  ','INGEST. ',
     > '  VEGET.','  MEAT  ','  MILK  '/
C           INITIALIZE
      IF (NTTB.EQ.0) GO TO 470
      DO 20 J=1,11
         DO 10 MD=1,8
   10       TOTJM(J,MD)=0
   20    CONTINUE
      DO 30 J=1,11
   30    TOTJ(J)=0
      DO 50 I=1,36
         DO 40 J=1,11
   40       TIJ(I,J)=0
   50    CONTINUE
      DO 70 I=1,NNUCS
         DO 60 J=1,11
            ORM=ORMODI(I,J,1)
            ORMODI(I,J,1)=ORMODI(I,J,2)
            ORMODI(I,J,2)=ORMODI(I,J,3)
            ORMODI(I,J,3)=ORMODI(I,J,5)
            ORMODI(I,J,5)=ORMODI(I,J,4)
            ORMODI(I,J,4)=ORM
   60       CONTINUE
   70    CONTINUE
      DO 100 I=1,NNUCS
         IF (NAMNUC(I).NE.NADRN.OR.NUTB.EQ.0)  GO TO 100
         DO 90 MD=1,5
            DO 80 J=1,12
               ORMODI(I,J,MD)=0
   80          CONTINUE
   90       CONTINUE
         GO TO 110
  100    CONTINUE
  110 CONTINUE
  120 DO 150 J=1,11
         DO 140 MD=1,8
            DO 130 I=1,NNUCS
  130          TOTJM(J,MD)=ORMODI(I,J,MD)+TOTJM(J,MD)
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140       CONTINUE                                                      DOSM 265
150    CONTINUE                                                         DOSM 270
    DO 170 J=1,11                                                       DOSM 275
       DO 160 MD=1,8                                                    DOSM 280
160       IF (TOTJM(J,MD).LT.1.E-40)  TOTJM(J,MD)=1.E-40                DOSM 285
170    CONTINUE                                                         DOSM 290
    DO 190 J=1,11                                                       DOSM 295
       DO 180 MD=1,5                                                    DOSM 300
180       TOTJ(J)=TOTJM(J,MD)+TOTJ(J)                                   DOSM 305
190    CONTINUE                                                         DOSM 310
    DO 220 J=1,11                                                       DOSM 315
       DO 200 MD=1,5                                                    DOSM 320
200       PTOJM(J,MD)=TOTJM(J,MD)/TOTJ(J)*100.                          DOSM 325
       DO 210 MD=6,8                                                    DOSM 330
210       PTOJM(J,MD)=TOTJM(J,5)/TOTJ(J)*100.0*TOTJM(J,MD)/TOTJM(J,5)   DOSM 335
220    CONTINUE                                                         DOSM 340
    DO 300 J=1,11                                                       DOSM 345
       WRITE(51,9000) NAMES(J)                                          DOSM 350
       IF (LIPO.EQ.1) GO TO 230                                         DOSM 355
       WRITE(51,9001)                                                   DOSM 360
       GO TO 240                                                        DOSM 365
230    WRITE(51,9002)                                                   DOSM 370
240    WRITE(51,9003)                                                   DOSM 375
       DO 290 I=1,NNUCS                                                 DOSM 380
          SUMA=0                                                        DOSM 385
          DO 250 MD=1,5                                                 DOSM 390
250          SUMA=ORMODI(I,J,MD)+SUMA                                   DOSM 395
          IF (SUMA.LT.1.E-40)  SUMA=1.E-40                              DOSM 400
          DO 260 MD=1,5                                                 DOSM 405
260          PCT(MD)=(ORMODI(I,J,MD)/SUMA)*100.                         DOSM 410
          MD=1                                                          DOSM 415
          PTOT=ORMODI(I,J,MD)/TOTJM(J,MD)*100.                          DOSM 420
          WRITE(51,9005) NAMNUC(I),MODE(MD),ORMODI(I,J,MD),PCT(MD),PTOTDOSM 425
          DO 270 MD=2,5                                                 DOSM 430
             PTOT=ORMODI(I,J,MD)/TOTJM(J,MD)*100.                       DOSM 435
270          WRITE(51,9004) MODE(MD),ORMODI(I,J,MD),PCT(MD),PTOT        DOSM 440
          DO 280 MD=6,8                                                 DOSM 445
             IF (ORMODI(I,J,5).EQ.0.)  PCT(MD)=0.                       DOSM 450
             IF (ORMODI(I,J,5).EQ.0.)  PTOT=0.                          DOSM 455
             IF (ORMODI(I,J,5).EQ.0.)  GO TO 280                        DOSM 460
             PCT(MD)=ORMODI(I,J,MD)/ORMODI(I,J,5)*PCT(5)                DOSM 465
             PTOT=ORMODI(I,J,MD)/TOTJM(J,5)*100.                        DOSM 470
280          WRITE(51,9006) MODE(MD),ORMODI(I,J,MD),FLAG(MD),PCT(MD),   DOSM 475
    >         FLAG(MD),PTOT                                             DOSM 480
290       CONTINUE                                                      DOSM 485
300    CONTINUE                                                         DOSM 490
    DO 340 J=1,11                                                       DOSM 495
       WRITE(51,9007) NAMES(J)                                          DOSM 500
       IF (LIPO.EQ.1) GO TO 310                                         DOSM 505
       WRITE(51,9008)                                                   DOSM 510
       GO TO 320                                                        DOSM 515
310    WRITE(51,9009)                                                   DOSM 520
320    DO 330 MD=1,8                                                    DOSM 525
          IF (TOTJM(J,MD).LE.1.E-40)  TOTJM(J,MD)=0.                    DOSM 530
          WRITE(51,9010) MODE(MD),FLAG(MD),TOTJM(J,MD),FLAG(MD),        DOSM 535
    >       PTOJM(J,MD)                                                 DOSM 540
330       CONTINUE                                                      DOSM 545
340    CONTINUE                                                         DOSM 550
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      WRITE(51,9011)                                                    DOSM 555
      IF (LIPO.EQ.1) GO TO 350                                          DOSM 560
      WRITE(51,9012)                                                    DOSM 565
      GO TO 360                                                         DOSM 570
  350 WRITE(51,9013)                                                    DOSM 575
  360 DO 370 J=1,11                                                     DOSM 580
  370    WRITE(51,9014) NAMES(J),TOTJ(J)                                DOSM 585
      DO 400 I=1,NNUCS                                                  DOSM 590
         DO 390 J=1,11                                                  DOSM 595
            DO 380 MD=1,5                                               DOSM 600
               TIJ(I,J)=ORMODI(I,J,MD)+TIJ(I,J)                         DOSM 605
  380          PTIJ(I,J)=TIJ(I,J)/TOTJ(J)*100.                          DOSM 610
  390       CONTINUE                                                    DOSM 615
  400    CONTINUE                                                       DOSM 620
      WRITE(51,9015)                                                    DOSM 625
      WRITE(51,9016)                                                    DOSM 630
      WRITE(51,9017) (NAMES(J),J=1,11)                                  DOSM 635
      WRITE(51,9019)                                                    DOSM 640
      DO 410 I=1,NNUCS                                                  DOSM 645
         WRITE(51,9018) NAMNUC(I),(PTIJ(I,J),J=1,11)                    DOSM 650
  410    CONTINUE                                                       DOSM 655
      IF (LIPO.EQ.1) GO TO 440                                          DOSM 660
      WRITE(51,9020)                                                    DOSM 665
      WRITE(51,9021)                                                    DOSM 670
      WRITE(51,9022)                                                    DOSM 675
      DO 430 I=1,NNUCS                                                  DOSM 680
         DO 420 J=1,11                                                  DOSM 685
            WRITE(51,9023) NAMNUC(I),NAMES(J),TIJ(I,J),NOML(J),NRML(J)  DOSM 690
  420       CONTINUE                                                    DOSM 695
  430    CONTINUE                                                       DOSM 700
      GO TO 470                                                         DOSM 705
  440 WRITE(51,9024)                                                    DOSM 710
      WRITE(51,9025)                                                    DOSM 715
      DO 460 I=1,NNUCS                                                  DOSM 720
         DO 450 J=1,11                                                  DOSM 725
            WRITE(51,9026) NAMNUC(I),NAMES(J),TIJ(I,J)                  DOSM 730
  450       CONTINUE                                                    DOSM 735
  460    CONTINUE                                                       DOSM 740
  470 CONTINUE                                                          DOSM 745
      IF (NUTB.EQ.0) GO TO 570                                          DOSM 750
      DO 480 I=1,NNUCS                                                  DOSM 755
         IF (NAMNUC(I).EQ.NADRN) GO TO 490                              DOSM 760
  480    CONTINUE                                                       DOSM 765
      GO TO 570                                                         DOSM 770
  490 CONTINUE                                                          DOSM 775
      ALI=LIPO                                                          DOSM 778
      CWL=0                                                             DOSM 779
      DO 510 NO=NOL,NOU                                                 DOSM 780
         DO 500 NR=NRL,NRU                                              DOSM 785
            IF (FEQWL.EQ.0.) FEQWL=0.7                                  DOSM 790
            WL(NO,NR)=FEQWL*10.*ACON(I,NO,NR)*(ALI*(INTPA(NC,NR)-1.)+1.)DOSM 795
            CWL=CWL+WL(NO,NR)                                           DOSM 796
  500       CONTINUE                                                    DOSM 800
  510    CONTINUE                                                       DOSM 805
      WRITE(51,9027)                                                    DOSM 810
      WRITE(51,9038) FEQWL                                              DOSM 815
      WRITE(51,9003)                                                    DOSM 820
      WRITE(51,9028)                                                    DOSM 825
      IF(LIPO.EQ.1) WRITE(51,9040)                                      DOSM 826
      WRITE(51,9019)                                                    DOSM 830
      IF (LORT.EQ.0) GO TO 520                                          DOSM 835
      WRITE(51,9029)                                                    DOSM 840
      WRITE(51,9030)                                                    DOSM 845
      WRITE(51,9003)                                                    DOSM 850
      GO TO 530                                                         DOSM 855
  520 WRITE(51,9031)                                                    DOSM 860
      WRITE(51,9003)                                                    DOSM 865
  530 CONTINUE                                                          DOSM 870
      IF (LORT.EQ.0) GO TO 540                                          DOSM 875
      WRITE(51,9032)(((NO,IDIST(NR),WL(NO,NR)),NR=NRL,NRU),NO=NOL,NOU)  DOSM 880
      GO TO 550                                                         DOSM 885
  540 WRITE(51,9033)(((NO,NR,WL(NO,NR)),NR=NRL,NRU),NO=NOL,NOU)         DOSM 890
  550 CONTINUE                                                          DOSM 895
  560 CONTINUE                                                          DOSM 900
      IF (LIPO.EQ.1) GO TO 569                                          DOSM 905
      WRITE(51,9034)                                                    DOSM 910
      WRITE(51,9035)                                                    DOSM 915
      WRITE(51,9036)                                                    DOSM 920
      WRITE(51,9019)                                                    DOSM 925
      WRITE(51,9037)((NAMES(J),NOML(J),NRML(J),WL(NOML(J),NRML(J))), J= DOSM 930
     > 1,11)                                                            DOSM 935
 569  IF(LIPO.EQ.1) WRITE(51,9039)CWL                                   DOSM 939
  570 CONTINUE                                                          DOSM 940
      RETURN                                                            DOSM 945
 9000 FORMAT('1',T36,'PERCENT OF ',A8,' DOSE BY EACH PATHWAY')          DOSM 950
 9001 FORMAT('0',T20,'NUCLIDE',T35,'PATHWAY',T52,'DOSE(REMS)', T70,     DOSM 955
     > 'PERCENT OF TOTAL',T90,'PERCENT OF DOSE FROM ALL NUCLIDES')      DOSM 960
 9002 FORMAT('0',T20,'NUCLIDE',T35,'PATHWAY',T50,'DOSE(MAN-REMS)', T70, DOSM 965
     > 'PERCENT OF TOTAL',T90,'PERCENT OF DOSE FROM ALL NUCLIDES')      DOSM 970
 9003 FORMAT('0')                                                       DOSM 975
 9004 FORMAT(' ',T35,A8,T52,E10.4,T75,F6.2,T103,F6.2)                   DOSM 980
 9005 FORMAT(' ',T20,A8,T35,A8,T52,E10.4,T75,F6.2,T103,F6.2)            DOSM 985
 9006 FORMAT(' ',T35,A8,T52,E10.4,T74,A1,F6.2,T102,A1,F6.2)             DOSM 990
 9007 FORMAT('0',T41,'CONTRIBUTION OF EXPOSURE MODES TO ',A8,' DOSES')  DOSM 995
 9008 FORMAT('0',T10,'EXPOSURE MODE',T57,'ANNUAL DOSE(REMS)',T99,       DOSM1000
     > 'PERCENT OF TOTAL DOSE')                                         DOSM1005
 9009 FORMAT('0',T10,'EXPOSURE MODE',T55,'ANNUAL DOSE(MAN-REMS)',T99,   DOSM1010
     > 'PERCENT OF TOTAL DOSE')                                         DOSM1015
 9010 FORMAT('0',T12,A8,T58,A1,E10.4,T103,A1,F10.4)                     DOSM1020
 9011 FORMAT('1',T43,'TOTAL DOSE TO EACH ORGAN THROUGH ALL PATHWAYS')   DOSM1025
 9012 FORMAT('0',T38,'ORGAN',T83,'DOSE(REMS)')                          DOSM1030
 9013 FORMAT('0',T38,'ORGAN',T81,'DOSE(MAN-REMS)')                      DOSM1035
 9014 FORMAT('0',T37,A8,T83,E10.4)                                      DOSM1040
 9015 FORMAT('1',T52,'CONTRIBUTORS TO ORGAN DOSES')                     DOSM1045
 9016 FORMAT('0',T80,'PERCENT')                                         DOSM1050
 9017 FORMAT('0',T2,'NUCLIDE',1X,11A11)                                 DOSM1055
 9018 FORMAT(' ',T2,A8,11F11.4)                                         DOSM1060
 9019 FORMAT(' ')                                                       DOSM1065
 9020 FORMAT('1',T56,'ANNUAL DOSES(REMS)')                              DOSM1070
 9021 FORMAT('0',T20,'NUCLIDE',T40,'ORGAN',T60,'DOSE',T100,             DOSM1075
     > 'MAXIMUM LOCATION')                                              DOSM1080
 9022 FORMAT('0',T101,'COLUMN',T112,'ROW')                              DOSM1085
 9023 FORMAT('0',T21,A8,T39,A8,T58,E10.4,T103,I2,T113,I2)               DOSM1090
 9024 FORMAT('1',T48,'ANNUAL POPULATION DOSES(MAN-REMS)')               DOSM1095
 9025 FORMAT('0',T38,'NUCLIDE',T62,'ORGAN',T85,'DOSE')                  DOSM1100
 9026 FORMAT('0',T39,A8,T61,A8,T83,E10.4)                               DOSM1105
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9027 FORMAT('1',T21,'WORKING LEVELS FOR RN-222 AND ITS SHORT-LIFE PROGEDOSM1110
     >NY AT VARIOUS LOCATIONS IN THE ENVIRONMENT')                     DOSM1115
9028 FORMAT(' ',T40,'AREA',T86,'WORKING LEVEL')                        DOSM1120
9029 FORMAT(' ',T32,'WIND TOWARD',T47,'DISTANCE')                      DOSM1125
9030 FORMAT(' ',T47,'(METERS)')                                        DOSM1130
9031 FORMAT(' ',T33,'COLUMN',T47,'ROW')                                DOSM1135
9032 FORMAT(' ',T36,I2,T47,I7,T87,E10.3)                               DOSM1140
9033 FORMAT(' ',T35,I2,T47,I2,T87,E10.3)                               DOSM1145
9034 FORMAT('1',T32,'WORKING LEVEL FOR RN-222 AND SHORT-LIFE PROGENY ATDOSM1150
     > LOCATION OF MAXIMUM')                                           DOSM1155
9035 FORMAT(' ',T43,'INDIVIDUAL DOSE FROM ALL PATHWAYS FOR EACH ORGAN')DOSM1160
9036 FORMAT('0',T35,'ORGAN',T56,'LOCATION OF MAXIMUM DOSE',T91,        DOSM1165
     > 'WORKING LEVEL')                                                DOSM1170
9037 FORMAT(' ',T34,A8,T63,I2,T71,I2,T93,E10.3)                        DOSM1175
9038 FORMAT(' ',T32,'(FRACTION OF EQUILIBRIUM ASSUMED FOR WORKING LEVELDOSM1180
     > CALCULATIONS=',F5.3,')')                                        DOSM1185
9039 FORMAT('0',T32,'COLLECTIVE WORKING LEVEL= ',E10.3)                DOSM1190
9040 FORMAT(' ',T86,'(POPULATION)')                                    DOSM1195
     END                                                               DOSM1200
```

Appendix B

OUTPUT OF AN EXAMPLE CASE RUN OF THE AIRDOS—EPA CODE

The example case is for a hypothetical atmospheric release of four radionuclides (^{226}Ra, ^{210}Po, ^{222}Rn, and ^{3}H) near ground level (1 m elevation) from a circular area source 1000 m in diameter. The meteorology and population distribution are representative of a western site in the U.S.

A period of 100 years was assumed for the buildup of radionuclides on ground surfaces resulting from aerial deposition. The buildup of two of the daughters of ^{226}Ra (^{210}Pb and ^{210}Po) on ground surface is calculated for this period.

The example run computes annual population doses (man-rem) within a radius of 88514 m (55 miles). Population-weighted concentrations in air and on ground surfaces, and population intake rates by ingestion and inhalation within this radius are also computed for each radionuclide at 11 distances away from the source in each of 16 compass directions. Working levels for ^{222}Rn are computed for each of these environmental locations.

Dose conversion factors for the external exposure modes used in the example run are from D. C. Kocher (1979). The internal dose conversion factors (inhalation and ingestion) are for 50-year dose commitments (Killough et al., 1978).

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                         OUTPUT OF AIRDOS-EPA COMPUTER CODE

OPTIONS SELECTED--
        RADIONUCLIDE CONCENTRATIONS ARE LISTED FOR DIRECTION AND DISTANCE FROM FACILITY

        RADIONUCLIDE CONCENTRATIONS LISTED ARE SECTOR-AVERAGED VALUES
        THE CALCULATIONS ARE MADE FOR A UNIFORM CIRCULAR AREA SOURCE
        SPECIFIC PLUME RISE USED FOR EACH AIR STABILITY CLASS (METERS)-
        A       0.0  B       0.0  C       0.0  D       0.0  E       0.0  F       0.0  G       0.0
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METEOROLOGICAL AND PLANT INFORMATION SUPPLIED TO PROGRAM----


         AVERAGE AIR TEMPERATURE (DEG K)                                  294.0
         AVERAGE VERTICAL TEMPERATURE GRADIENT OF THE AIR (DEG K/METER)
                  IN STABILITY CLASS E                                   0.0728
                  IN STABILITY CLASS F                                   0.1090
                  IN STABILITY CLASS G                                   0.1455
         RAINFALL RATE (CM/YEAR)                                          20.32
         HEIGHT OF LID (METERS)                                            2000
         NUMBER OF STACKS IN THE PLANT                                        1


         STACK INFORMATION--


                                                          STACK NUMBER
                                         1         2         3         4         5         6
HEIGHT (METERS)                       1.0000
DIAMETER (METERS)                     0.0
EFFLUENT VELOCITY (METERS/SEC)        0.0
RATE OF HEAT EMISSION (CAL/SECOND)  0.0
DIAMETER OF AREA SOURCE (METERS)   1000.0000
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    RELEASE RATES FOR RADIONUCLIDES

STACK         NUCLIDE        RELEASE RATE
                             (CURIES/YEAR)

  1            RA-226         0.100E-01
  1            PB-210         0.0
  1            PO-210         0.200E-01
  1            RN-222         0.100E 01
  1            H-3            0.100E 01
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                       PLUME DEPLETION AND DEPOSITION PARAMETERS

NUCLIDE          GRAVITATIONAL     DEPOSITION VELOCITY     SCAVENGING     EFFECTIVE DECAY CONSTANT
                 FALL VELOCITY                             COEFFICIENT           IN PLUME
                 (METERS/SEC)         (METERS/SEC)           (1/SEC)             (PER DAY)


 RA-226              0.0                0.01000             0.460E-05           0.119E-05
 PB-210              0.0                0.01000             0.460E-05           0.852E-04
 PO-210              0.0                0.01000             0.460E-05           0.502E-02
 RN-222              0.0                0.0                 0.0                 0.181E 00
 H-3                 0.0                0.0                 0.0                 0.154E-03
```

FREQUENCY OF ATMOSPHERIC STABILITY CLASSES FOR EACH DIRECTION

SECTOR	FRACTION OF TIME IN EACH STABILITY CLASS						
	A	B	C	D	E	F	G
1	0.0266	0.1531	0.1764	0.2935	0.1167	0.2337	0.0
2	0.0173	0.1026	0.1137	0.1939	0.1629	0.4096	0.0
3	0.0150	0.0710	0.0721	0.1817	0.1754	0.4848	0.0
4	0.0120	0.0420	0.0442	0.4096	0.1356	0.3566	0.0
5	0.0092	0.0460	0.0369	0.5786	0.0867	0.2426	0.0
6	0.0218	0.1033	0.0614	0.2902	0.1291	0.3942	0.0
7	0.0256	0.1180	0.0764	0.1654	0.1370	0.4776	0.0
8	0.0089	0.1101	0.1003	0.1727	0.2399	0.3682	0.0
9	0.0159	0.0889	0.1203	0.2928	0.2153	0.2667	0.0
10	0.0155	0.1335	0.1613	0.2935	0.1447	0.2514	0.0
11	0.0326	0.1855	0.1526	0.3277	0.1003	0.2013	0.0
12	0.0427	0.2116	0.1474	0.3271	0.0900	0.1812	0.0
13	0.0527	0.2398	0.1703	0.3032	0.0823	0.1517	0.0
14	0.0444	0.2267	0.1727	0.3226	0.0891	0.1444	0.0
15	0.0409	0.2368	0.2057	0.2873	0.0897	0.1397	0.0
16	0.0308	0.1856	0.2092	0.3364	0.1073	0.1308	0.0

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FREQUENCIES OF WIND DIRECTIONS AND RECIPROCAL-AVERAGED WIND SPEEDS


WIND TOWARD              FREQUENCY                WIND SPEEDS FOR EACH STABILITY CLASS
                                                              (METERS/SEC)

                                          A       B       C       D       E       F       G


     1                     0.091        1.30    1.37    2.45    4.00    3.27    1.13    0.0
     2                     0.054        1.26    1.24    2.14    3.30    3.14    1.26    0.0
     3                     0.083        1.00    1.11    1.80    3.40    3.08    1.27    0.0
     4                     0.081        1.10    1.02    1.91    5.53    3.23    1.23    0.0
     5                     0.053        1.00    1.03    2.18    6.11    3.37    1.11    0.0
     6                     0.027        0.98    1.08    1.61    3.98    3.27    1.08    0.0
     7                     0.040        0.97    1.05    1.92    2.84    3.31    1.16    0.0
     8                     0.048        1.31    1.19    2.11    3.16    3.64    1.27    0.0
     9                     0.129        1.19    1.14    2.43    4.01    3.81    1.33    0.0
    10                     0.064        1.28    1.23    2.49    4.15    3.55    1.31    0.0
    11                     0.056        1.29    1.23    2.29    4.27    3.50    1.18    0.0
    12                     0.053        1.28    1.34    2.52    4.56    3.30    1.11    0.0
    13                     0.048        1.19    1.40    2.48    4.72    3.21    1.10    0.0
    14                     0.053        1.27    1.58    2.89    4.51    3.26    1.14    0.0
    15                     0.064        1.32    1.48    2.80    3.96    3.28    1.08    0.0
    16                     0.055        1.22    1.64    2.94    4.99    3.33    1.14    0.0

WIND DIRECTIONS ARE NUMBERED COUNTERCLOCKWISE STARTING AT 1 FOR DUE NORTH
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FREQUENCIES OF WIND DIRECTIONS AND TRUE-AVERAGE WIND SPEEDS

WIND TOWARD	FREQUENCY	WIND SPEEDS FOR EACH STABILITY CLASS (METERS/SEC)						
		A	B	C	D	E	F	G
1	0.091	1.82	2.22	3.59	5.70	3.51	1.58	0.0
2	0.054	1.78	1.96	3.19	4.64	3.37	1.77	0.0
3	0.083	1.36	1.72	2.79	5.17	3.30	1.79	0.0
4	0.081	1.53	1.52	3.24	7.11	3.47	1.73	0.0
5	0.053	1.36	1.48	3.62	7.66	3.61	1.55	0.0
6	0.027	1.32	1.64	2.74	5.96	3.50	1.50	0.0
7	0.040	1.29	1.56	2.84	4.12	3.55	1.64	0.0
8	0.048	1.83	1.83	2.90	4.46	3.86	1.78	0.0
9	0.129	1.67	1.78	3.28	5.36	4.00	1.86	0.0
10	0.064	1.80	1.84	3.30	5.61	3.78	1.83	0.0
11	0.056	1.81	1.93	3.33	6.33	3.73	1.66	0.0
12	0.053	1.79	2.10	3.63	6.52	3.54	1.57	0.0
13	0.048	1.68	2.20	3.71	6.32	3.44	1.54	0.0
14	0.053	1.78	2.46	3.95	6.02	3.50	1.60	0.0
15	0.064	1.84	2.37	3.92	5.69	3.52	1.51	0.0
16	0.055	1.72	2.52	4.03	6.12	3.57	1.61	0.0

WIND DIRECTIONS ARE NUMBERED COUNTERCLOCKWISE STARTING AT 1 FOR DUE NORTH

ESTIMATED RADIONUCLIDE CONCENTRATIONS

AREA WIND TOWARD	DISTANCE (METERS)	NUCLIDE	AIR CONCENTRATION (PCI/CC)	DRY DEPOSITION RATE (PCI/SQUARE CM-SEC)	WET DEPOSITION RATE (PCI/SQUARE CM-SEC)	GROUND DEPOSITION RATE (PCI/SQUARE CM-SEC)
1	1207	RA-226	0.292E-09	0.292E-09	0.671E-11	0.299E-09
1	1207	PB-210	0.0	0.0	0.0	0.0
1	1207	PO-210	0.584E-09	0.584E-09	0.134E-10	0.598E-09
1	1207	RN-222	0.767E-07	0.0	0.0	0.0
1	1207	H-3	0.769E-07	0.0	0.0	0.0
1	2414	RA-226	0.862E-10	0.862E-10	0.377E-11	0.900E-10
1	2414	PB-210	0.0	0.0	0.0	0.0
1	2414	PO-210	0.172E-09	0.172E-09	0.753E-11	0.180E-09
1	2414	RN-222	0.291E-07	0.0	0.0	0.0
1	2414	H-3	0.292E-07	0.0	0.0	0.0
1	4023	RA-226	0.310E-10	0.310E-10	0.207E-11	0.330E-10
1	4023	PB-210	0.0	0.0	0.0	0.0
1	4023	PO-210	0.619E-10	0.619E-10	0.415E-11	0.661E-10
1	4023	RN-222	0.134E-07	0.0	0.0	0.0
1	4023	H-3	0.134E-07	0.0	0.0	0.0
1	5632	RA-226	0.165E-10	0.165E-10	0.142E-11	0.180E-10
1	5632	PB-210	0.0	0.0	0.0	0.0
1	5632	PO-210	0.331E-10	0.331E-10	0.283E-11	0.359E-10
1	5632	RN-222	0.827E-08	0.0	0.0	0.0
1	5632	H-3	0.835E-08	0.0	0.0	0.0
1	7241	RA-226	0.990E-11	0.990E-11	0.105E-11	0.110E-10
1	7241	PB-210	0.0	0.0	0.0	0.0
1	7241	PO-210	0.198E-10	0.198E-10	0.210E-11	0.219E-10
1	7241	RN-222	0.579E-08	0.0	0.0	0.0
1	7241	H-3	0.586E-08	0.0	0.0	0.0
1	12068	RA-226	0.387E-11	0.387E-11	0.587E-12	0.446E-11
1	12068	PB-210	0.0	0.0	0.0	0.0
1	12068	PO-210	0.775E-11	0.775E-11	0.117E-11	0.892E-11
1	12068	RN-222	0.293E-08	0.0	0.0	0.0
1	12068	H-3	0.299E-08	0.0	0.0	0.0
1	20113	RA-226	0.161E-11	0.161E-11	0.323E-12	0.194E-11
1	20113	PB-210	0.0	0.0	0.0	0.0
1	20113	PO-210	0.323E-11	0.323E-11	0.647E-12	0.387E-11
1	20113	RN-222	0.161E-08	0.0	0.0	0.0
1	20113	H-3	0.166E-08	0.0	0.0	0.0
1	32180	RA-226	0.680E-12	0.680E-12	0.181E-12	0.861E-12
1	32180	PB-210	0.0	0.0	0.0	0.0
1	32180	PO-210	0.136E-11	0.136E-11	0.362E-12	0.172E-11
1	32180	RN-222	0.920E-09	0.0	0.0	0.0
1	32180	H-3	0.971E-09	0.0	0.0	0.0
1	48270	RA-226	0.337E-12	0.337E-12	0.108E-12	0.445E-12
1	48270	PB-210	0.0	0.0	0.0	0.0
1	48270	PO-210	0.674E-12	0.674E-12	0.215E-12	0.889E-12
1	48270	RN-222	0.565E-09	0.0	0.0	0.0
1	48270	H-3	0.613E-09	0.0	0.0	0.0
1	64360	RA-226	0.174E-12	0.174E-12	0.707E-13	0.245E-12
1	64360	PB-210	0.0	0.0	0.0	0.0
1	64360	PO-210	0.349E-12	0.349E-12	0.141E-12	0.490E-12
1	64360	RN-222	0.397E-09	0.0	0.0	0.0
1	64360	H-3	0.442E-09	0.0	0.0	0.0
1	80450	RA-226	0.113E-12	0.113E-12	0.513E-13	0.165E-12
1	80450	PB-210	0.0	0.0	0.0	0.0
1	80450	PO-210	0.226E-12	0.226E-12	0.103E-12	0.329E-12
1	80450	RN-222	0.300E-09	0.0	0.0	0.0
1	80450	H-3	0.344E-09	0.0	0.0	0.0

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2      1207   RA-226   0.340E-09     0.340E-09     0.618E-11     0.347E-09
2      1207   PB-210   0.0           0.0           0.0           0.0
2      1207   PO-210   0.681E-09     0.681E-09     0.124E-10     0.693E-09
2      1207   RN-222   0.954E-07     0.0           0.0           0.0
2      1207   H-3      0.956E-07     0.0           0.0           0.0
2      2414   RA-226   0.666E-10     0.666E-10     0.206E-11     0.687E-10
2      2414   PB-210   0.0           0.0           0.0           0.0
2      2414   PO-210   0.133E-09     0.133E-09     0.413E-11     0.137E-09
2      2414   RN-222   0.246E-07     0.0           0.0           0.0
2      2414   H-3      0.247E-07     0.0           0.0           0.0
2      4023   RA-226   0.231E-10     0.231E-10     0.108E-11     0.242E-10
2      4023   PB-210   0.0           0.0           0.0           0.0
2      4023   PO-210   0.463E-10     0.463E-10     0.217E-11     0.484E-10
2      4023   RN-222   0.114E-07     0.0           0.0           0.0
2      4023   H-3      0.115E-07     0.0           0.0           0.0
2      5632   RA-226   0.121E-10     0.121E-10     0.722E-12     0.129E-10
2      5632   PB-210   0.0           0.0           0.0           0.0
2      5632   PO-210   0.243E-10     0.243E-10     0.144E-11     0.257E-10
2      5632   RN-222   0.713E-08     0.0           0.0           0.0
2      5632   H-3      0.719E-08     0.0           0.0           0.0
2      7241   RA-226   0.699E-11     0.699E-11     0.521E-12     0.751E-11
2      7241   PB-210   0.0           0.0           0.0           0.0
2      7241   PO-210   0.140E-10     0.140E-10     0.104E-11     0.150E-10
2      7241   RN-222   0.501E-08     0.0           0.0           0.0
2      7241   H-3      0.507E-08     0.0           0.0           0.0
2     12068   RA-226   0.260E-11     0.260E-11     0.280E-12     0.288E-11
2     12068   PB-210   0.0           0.0           0.0           0.0
2     12068   PO-210   0.520E-11     0.520E-11     0.559E-12     0.576E-11
2     12068   RN-222   0.256E-08     0.0           0.0           0.0
2     12068   H-3      0.261E-08     0.0           0.0           0.0
2     20113   RA-226   0.103E-11     0.103E-11     0.148E-12     0.117E-11
2     20113   PB-210   0.0           0.0           0.0           0.0
2     20113   PO-210   0.205E-11     0.205E-11     0.297E-12     0.235E-11
2     20113   RN-222   0.142E-08     0.0           0.0           0.0
2     20113   H-3      0.146E-08     0.0           0.0           0.0
2     32180   RA-226   0.384E-12     0.384E-12     0.795E-13     0.463E-12
2     32180   PB-210   0.0           0.0           0.0           0.0
2     32180   PO-210   0.767E-12     0.767E-12     0.159E-12     0.926E-12
2     32180   RN-222   0.820E-09     0.0           0.0           0.0
2     32180   H-3      0.862E-09     0.0           0.0           0.0
2     48270   RA-226   0.184E-12     0.184E-12     0.461E-13     0.230E-12
2     48270   PB-210   0.0           0.0           0.0           0.0
2     48270   PO-210   0.367E-12     0.367E-12     0.923E-13     0.460E-12
2     48270   RN-222   0.507E-09     0.0           0.0           0.0
2     48270   H-3      0.547E-09     0.0           0.0           0.0
2     64360   RA-226   0.840E-13     0.840E-13     0.291E-13     0.113E-12
2     64360   PB-210   0.0           0.0           0.0           0.0
2     64360   PO-210   0.168E-12     0.168E-12     0.582E-13     0.226E-12
2     64360   RN-222   0.358E-09     0.0           0.0           0.0
2     64360   H-3      0.396E-09     0.0           0.0           0.0
2     80450   RA-226   0.529E-13     0.529E-13     0.208E-13     0.737E-13
2     80450   PB-210   0.0           0.0           0.0           0.0
2     80450   PO-210   0.106E-12     0.106E-12     0.415E-13     0.147E-12
2     80450   RN-222   0.272E-09     0.0           0.0           0.0
2     80450   H-3      0.308E-09     0.0           0.0           0.0
3      1207   RA-226   0.401E-09     0.401E-09     0.625E-11     0.408E-09
3      1207   PB-210   0.0           0.0           0.0           0.0
3      1207   PO-210   0.803E-09     0.803E-09     0.125E-10     0.815E-09
3      1207   RN-222   0.116E-06     0.0           0.0           0.0
3      1207   H-3      0.116E-06     0.0           0.0           0.0
3      2414   RA-226   0.111E-09     0.111E-09     0.297E-11     0.114E-09
3      2414   PB-210   0.0           0.0           0.0           0.0
3      2414   PO-210   0.222E-09     0.222E-09     0.594E-11     0.228E-09
3      2414   RN-222   0.431E-07     0.0           0.0           0.0
3      2414   H-3      0.433E-07     0.0           0.0           0.0
3      4023   RA-226   0.380E-10     0.380E-10     0.152E-11     0.396E-10
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3    4023  PB-210  0.0           0.0           0.0           0.0
3    4023  PO-210  0.761E-10     0.761E-10     0.304E-11     0.791E-10
3    4023  RN-222  0.201E-07     0.0           0.0           0.0
3    4023  H-3     0.202E-07     0.0           0.0           0.0
3    5632  RA-226  0.198E-10     0.198E-10     0.998E-12     0.208E-10
3    5632  PB-210  0.0           0.0           0.0           0.0
3    5632  PO-210  0.397E-10     0.397E-10     0.200E-11     0.417E-10
3    5632  RN-222  0.125E-07     0.0           0.0           0.0
3    5632  H-3     0.127E-07     0.0           0.0           0.0
3    7241  RA-226  0.113E-10     0.113E-10     0.708E-12     0.120E-10
3    7241  PB-210  0.0           0.0           0.0           0.0
3    7241  PO-210  0.226E-10     0.226E-10     0.142E-11     0.240E-10
3    7241  RN-222  0.883E-08     0.0           0.0           0.0
3    7241  H-3     0.893E-08     0.0           0.0           0.0
3   12068  RA-226  0.414E-11     0.414E-11     0.371E-12     0.451E-11
3   12068  PB-210  0.0           0.0           0.0           0.0
3   12068  PO-210  0.828E-11     0.828E-11     0.742E-12     0.902E-11
3   12068  RN-222  0.453E-08     0.0           0.0           0.0
3   12068  H-3     0.462E-08     0.0           0.0           0.0
3   20113  RA-226  0.160E-11     0.160E-11     0.192E-12     0.179E-11
3   20113  PB-210  0.0           0.0           0.0           0.0
3   20113  PO-210  0.320E-11     0.320E-11     0.384E-12     0.358E-11
3   20113  RN-222  0.252E-08     0.0           0.0           0.0
3   20113  H-3     0.260E-08     0.0           0.0           0.0
3   32180  RA-226  0.573E-12     0.573E-12     0.997E-13     0.672E-12
3   32180  PB-210  0.0           0.0           0.0           0.0
3   32180  PO-210  0.115E-11     0.115E-11     0.199E-12     0.134E-11
3   32180  RN-222  0.146E-08     0.0           0.0           0.0
3   32180  H-3     0.153E-08     0.0           0.0           0.0
3   48270  RA-226  0.270E-12     0.270E-12     0.568E-13     0.327E-12
3   48270  PB-210  0.0           0.0           0.0           0.0
3   48270  PO-210  0.540E-12     0.540E-12     0.114E-12     0.654E-12
3   48270  RN-222  0.902E-09     0.0           0.0           0.0
3   48270  H-3     0.972E-09     0.0           0.0           0.0
3   64360  RA-226  0.117E-12     0.117E-12     0.347E-13     0.152E-12
3   64360  PB-210  0.0           0.0           0.0           0.0
3   64360  PO-210  0.235E-12     0.235E-12     0.693E-13     0.304E-12
3   64360  RN-222  0.638E-09     0.0           0.0           0.0
3   64360  H-3     0.705E-09     0.0           0.0           0.0
3   80450  RA-226  0.730E-13     0.730E-13     0.244E-13     0.974E-13
3   80450  PB-210  0.0           0.0           0.0           0.0
3   80450  PO-210  0.146E-12     0.146E-12     0.487E-13     0.195E-12
3   80450  RN-222  0.485E-09     0.0           0.0           0.0
3   80450  H-3     0.549E-09     0.0           0.0           0.0
4    1207  RA-226  0.350E-09     0.350E-09     0.548E-11     0.355E-09
4    1207  PB-210  0.0           0.0           0.0           0.0
4    1207  PO-210  0.700E-09     0.700E-09     0.110E-10     0.711E-09
4    1207  RN-222  0.100E-06     0.0           0.0           0.0
4    1207  H-3     0.100E-06     0.0           0.0           0.0
4    2414  RA-226  0.888E-10     0.888E-10     0.242E-11     0.913E-10
4    2414  PB-210  0.0           0.0           0.0           0.0
4    2414  PO-210  0.178E-09     0.178E-09     0.483E-11     0.183E-09
4    2414  RN-222  0.329E-07     0.0           0.0           0.0
4    2414  H-3     0.330E-07     0.0           0.0           0.0
4    4023  RA-226  0.314E-10     0.314E-10     0.126E-11     0.327E-10
4    4023  PB-210  0.0           0.0           0.0           0.0
4    4023  PO-210  0.628E-10     0.628E-10     0.252E-11     0.654E-10
4    4023  RN-222  0.153E-07     0.0           0.0           0.0
4    4023  H-3     0.154E-07     0.0           0.0           0.0
4    5632  RA-226  0.167E-10     0.167E-10     0.837E-12     0.176E-10
4    5632  PB-210  0.0           0.0           0.0           0.0
4    5632  PO-210  0.335E-10     0.335E-10     0.167E-11     0.351E-10
4    5632  RN-222  0.955E-08     0.0           0.0           0.0
4    5632  H-3     0.963E-08     0.0           0.0           0.0
4    7241  RA-226  0.982E-11     0.982E-11     0.602E-12     0.134E-10
4    7241  PB-210  0.0           0.0           0.0           0.0
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4     7241   PO-210   0.196E-10   0.196E-10   0.120E-11   0.208E-10
4     7241   RN-222   0.672E-08   0.0         0.0         0.0
4     7241   H-3      0.679E-08   0.0         0.0         0.0
4    12068   RA-226   0.378E-11   0.378E-11   0.323E-12   0.410E-11
4    12068   PB-210   0.0         0.0         0.0         0.0
4    12068   PO-210   0.755E-11   0.755E-11   0.645E-12   0.820E-11
4    12068   RN-222   0.344E-08   0.0         0.0         0.0
4    12068   H-3      0.350E-08   0.0         0.0         0.0
4    20113   RA-226   0.152E-11   0.152E-11   0.171E-12   0.169E-11
4    20113   PB-210   0.0         0.0         0.0         0.0
4    20113   PO-210   0.303E-11   0.303E-11   0.343E-12   0.338E-11
4    20113   RN-222   0.190E-08   0.0         0.0         0.0
4    20113   H-3      0.196E-08   0.0         0.0         0.0
4    32180   RA-226   0.594E-12   0.594E-12   0.922E-13   0.686E-12
4    32180   PB-210   0.0         0.0         0.0         0.0
4    32180   PO-210   0.119E-11   0.119E-11   0.184E-12   0.137E-11
4    32180   RN-222   0.110E-08   0.0         0.0         0.0
4    32180   H-3      0.115E-08   0.0         0.0         0.0
4    48270   RA-226   0.289E-12   0.289E-12   0.541E-13   0.343E-12
4    48270   PB-210   0.0         0.0         0.0         0.0
4    48270   PO-210   0.579E-12   0.579E-12   0.108E-12   0.687E-12
4    48270   RN-222   0.676E-09   0.0         0.0         0.0
4    48270   H-3      0.730E-09   0.0         0.0         0.0
4    64360   RA-226   0.142E-12   0.142E-12   0.344E-13   0.176E-12
4    64360   PB-210   0.0         0.0         0.0         0.0
4    64360   PO-210   0.284E-12   0.284E-12   0.688E-13   0.353E-12
4    64360   RN-222   0.477E-09   0.0         0.0         0.0
4    64360   H-3      0.528E-09   0.0         0.0         0.0
4    80450   RA-226   0.918E-13   0.918E-13   0.249E-13   0.117E-12
4    80450   PB-210   0.0         0.0         0.0         0.0
4    80450   PO-210   0.184E-12   0.184E-12   0.497E-13   0.233E-12
4    80450   RN-222   0.362E-09   0.0         0.0         0.0
4    80450   H-3      0.411E-09   0.0         0.0         0.0
5     1207   RA-226   0.217E-09   0.217E-09   0.367E-11   0.221E-09
5     1207   PB-210   0.0         0.0         0.0         0.0
5     1207   PO-210   0.434E-09   0.434E-09   0.734E-11   0.441E-09
5     1207   RN-222   0.630E-07   0.0         0.0         0.0
5     1207   H-3      0.631E-07   0.0         0.0         0.0
5     2414   RA-226   0.466E-10   0.466E-10   0.147E-11   0.480E-10
5     2414   PB-210   0.0         0.0         0.0         0.0
5     2414   PO-210   0.931E-10   0.931E-10   0.293E-11   0.961E-10
5     2414   RN-222   0.169E-07   0.0         0.0         0.0
5     2414   H-3      0.170E-07   0.0         0.0         0.0
5     4023   RA-226   0.169E-10   0.169E-10   0.789E-12   0.177E-10
5     4023   PB-210   0.0         0.0         0.0         0.0
5     4023   PO-210   0.339E-10   0.339E-10   0.158E-11   0.355E-10
5     4023   RN-222   0.785E-08   0.0         0.0         0.0
5     4023   H-3      0.790E-08   0.0         0.0         0.0
5     5632   RA-226   0.918E-11   0.918E-11   0.533E-12   0.972E-11
5     5632   PB-210   0.0         0.0         0.0         0.0
5     5632   PO-210   0.184E-10   0.184E-10   0.107E-11   0.194E-10
5     5632   RN-222   0.489E-08   0.0         0.0         0.0
5     5632   H-3      0.494E-08   0.0         0.0         0.0
5     7241   RA-226   0.557E-11   0.557E-11   0.391E-12   0.596E-11
5     7241   PB-210   0.0         0.0         0.0         0.0
5     7241   PO-210   0.111E-10   0.111E-10   0.783E-12   0.119E-10
5     7241   RN-222   0.344E-08   0.0         0.0         0.0
5     7241   H-3      0.348E-08   0.0         0.0         0.0
5    12068   RA-226   0.223E-11   0.223E-11   0.216E-12   0.244E-11
5    12068   PB-210   0.0         0.0         0.0         0.0
5    12068   PO-210   0.446E-11   0.446E-11   0.432E-12   0.489E-11
5    12068   RN-222   0.175E-08   0.0         0.0         0.0
5    12068   H-3      0.178E-08   0.0         0.0         0.0
5    20113   RA-226   0.926E-12   0.926E-12   0.118E-12   0.104E-11
5    20113   PB-210   0.0         0.0         0.0         0.0
5    20113   PO-210   0.185E-11   0.185E-11   0.236E-12   0.209E-11
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5    20113   RN-222   0.957E-09   0.0         0.0         0.0
5    20113   H-3      0.990E-09   0.0         0.0         0.0
5    32180   RA-226   0.392E-12   0.392E-12   0.657E-13   0.458E-12
5    32180   PB-210   0.0         0.0         0.0         0.0
5    32180   PO-210   0.784E-12   0.784E-12   0.131E-12   0.915E-12
5    32180   RN-222   0.548E-09   0.0         0.0         0.0
5    32180   H-3      0.579E-09   0.0         0.0         0.0
5    48270   RA-226   0.195E-12   0.195E-12   0.393E-13   0.234E-12
5    48270   PB-210   0.0         0.0         0.0         0.0
5    48270   PO-210   0.390E-12   0.390E-12   0.787E-13   0.468E-12
5    48270   RN-222   0.336E-09   0.0         0.0         0.0
5    48270   H-3      0.365E-09   0.0         0.0         0.0
5    64360   RA-226   0.104E-12   0.104E-12   0.258E-13   0.130E-12
5    64360   PB-210   0.0         0.0         0.0         0.0
5    64360   PO-210   0.209E-12   0.209E-12   0.515E-13   0.261E-12
5    64360   RN-222   0.236E-09   0.0         0.0         0.0
5    64360   H-3      0.263E-09   0.0         0.0         0.0
5    80450   RA-226   0.688E-13   0.688E-13   0.189E-13   0.877E-13
5    80450   PB-210   0.0         0.0         0.0         0.0
5    80450   PO-210   0.138E-12   0.138E-12   0.377E-13   0.175E-12
5    80450   RN-222   0.178E-09   0.0         0.0         0.0
5    80450   H-3      0.205E-09   0.0         0.0         0.0
6     1207   RA-226   0.164E-09   0.164E-09   0.293E-11   0.167E-09
6     1207   PB-210   0.0         0.0         0.0         0.0
6     1207   PO-210   0.329E-09   0.329E-09   0.586E-11   0.334E-09
6     1207   RN-222   0.518E-07   0.0         0.0         0.0
6     1207   H-3      0.519E-07   0.0         0.0         0.0
6     2414   RA-226   0.302E-10   0.302E-10   0.101E-11   0.312E-10
6     2414   PB-210   0.0         0.0         0.0         0.0
6     2414   PO-210   0.603E-10   0.603E-10   0.202E-11   0.623E-10
6     2414   RN-222   0.135E-07   0.0         0.0         0.0
6     2414   H-3      0.136E-07   0.0         0.0         0.0
6     4023   RA-226   0.103E-10   0.103E-10   0.531E-12   0.108E-10
6     4023   PB-210   0.0         0.0         0.0         0.0
6     4023   PO-210   0.206E-10   0.206E-10   0.106E-11   0.216E-10
6     4023   RN-222   0.627E-08   0.0         0.0         0.0
6     4023   H-3      0.631E-08   0.0         0.0         0.0
6     5632   RA-226   0.536E-11   0.536E-11   0.355E-12   0.572E-11
6     5632   PB-210   0.0         0.0         0.0         0.0
6     5632   PO-210   0.107E-10   0.107E-10   0.710E-12   0.114E-10
6     5632   RN-222   0.391E-08   0.0         0.0         0.0
6     5632   H-3      0.395E-08   0.0         0.0         0.0
6     7241   RA-226   0.310E-11   0.310E-11   0.257E-12   0.335E-11
6     7241   PB-210   0.0         0.0         0.0         0.0
6     7241   PO-210   0.619E-11   0.619E-11   0.515E-12   0.671E-11
6     7241   RN-222   0.275E-08   0.0         0.0         0.0
6     7241   H-3      0.278E-08   0.0         0.0         0.0
6    12068   RA-226   0.117E-11   0.117E-11   0.140E-12   0.130E-11
6    12068   PB-210   0.0         0.0         0.0         0.0
6    12068   PO-210   0.233E-11   0.233E-11   0.279E-12   0.261E-11
6    12068   RN-222   0.140E-08   0.0         0.0         0.0
6    12068   H-3      0.143E-08   0.0         0.0         0.0
6    20113   RA-226   0.468E-12   0.468E-12   0.747E-13   0.542E-12
6    20113   PB-210   0.0         0.0         0.0         0.0
6    20113   PO-210   0.935E-12   0.935E-12   0.149E-12   0.108E-11
6    20113   RN-222   0.776E-09   0.0         0.0         0.0
6    20113   H-3      0.804E-09   0.0         0.0         0.0
6    32180   RA-226   0.188E-12   0.188E-12   0.404E-13   0.228E-12
6    32180   PB-210   0.0         0.0         0.0         0.0
6    32180   PO-210   0.375E-12   0.375E-12   0.807E-13   0.456E-12
6    32180   RN-222   0.447E-09   0.0         0.0         0.0
6    32180   H-3      0.474E-09   0.0         0.0         0.0
6    48270   RA-226   0.915E-13   0.915E-13   0.233E-13   0.115E-12
6    48270   PB-210   0.0         0.0         0.0         0.0
6    48270   PO-210   0.183E-12   0.183E-12   0.466E-13   0.230E-12
6    48270   RN-222   0.275E-09   0.0         0.0         0.0
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6     48270   H-3      0.300E-09    0.0          0.0          0.0
6     64360   RA-226   0.451E-13    0.451E-13    0.147E-13    0.598E-13
6     64360   PB-210   0.0          0.0          0.0          0.0
6     64360   PO-210   0.902E-13    0.902E-13    0.293E-13    0.120E-12
6     64360   RN-222   0.193E-09    0.0          0.0          0.0
6     64360   H-3      0.217E-09    0.0          0.0          0.0
6     80450   RA-226   0.288E-13    0.288E-13    0.103E-13    0.392E-13
6     80450   PB-210   0.0          0.0          0.0          0.0
6     80450   PO-210   0.577E-13    0.577E-13    0.207E-13    0.793E-13
6     80450   RN-222   0.146E-09    0.0          0.0          0.0
6     80450   H-3      0.169E-09    0.0          0.0          0.0
7      1207   RA-226   0.203E-09    0.203E-09    0.356E-11    0.206E-09
7      1207   PB-210   0.0          0.0          0.0          0.0
7      1207   PO-210   0.406E-09    0.406E-09    0.713E-11    0.413E-09
7      1207   RN-222   0.625E-07    0.0          0.0          0.0
7      1207   H-3      0.626E-07    0.0          0.0          0.0
7      2414   RA-226   0.500E-10    0.500E-10    0.160E-11    0.516E-10
7      2414   PB-210   0.0          0.0          0.0          0.0
7      2414   PO-210   0.100E-09    0.100E-09    0.320E-11    0.103E-09
7      2414   RN-222   0.221E-07    0.0          0.0          0.0
7      2414   H-3      0.222E-07    0.0          0.0          0.0
7      4023   RA-226   0.167E-10    0.167E-10    0.831E-12    0.175E-10
7      4023   PB-210   0.0          0.0          0.0          0.0
7      4023   PO-210   0.334E-10    0.334E-10    0.166E-11    0.351E-10
7      4023   RN-222   0.103E-07    0.0          0.0          0.0
7      4023   H-3      0.103E-07    0.0          0.0          0.0
7      5632   RA-226   0.858E-11    0.858E-11    0.550E-12    0.913E-11
7      5632   PB-210   0.0          0.0          0.0          0.0
7      5632   PO-210   0.172E-10    0.172E-10    0.110E-11    0.193E-10
7      5632   RN-222   0.641E-08    0.0          0.0          0.0
7      5632   H-3      0.647E-08    0.0          0.0          0.0
7      7241   RA-226   0.482E-11    0.482E-11    0.395E-12    0.521E-11
7      7241   PB-210   0.0          0.0          0.0          0.0
7      7241   PO-210   0.964E-11    0.964E-11    0.791E-12    0.104E-10
7      7241   RN-222   0.450E-08    0.0          0.0          0.0
7      7241   H-3      0.456E-08    0.0          0.0          0.0
7     12068   RA-226   0.174E-11    0.174E-11    0.211E-12    0.195E-11
7     12068   PB-210   0.0          0.0          0.0          0.0
7     12068   PO-210   0.348E-11    0.348E-11    0.423E-12    0.390E-11
7     12068   RN-222   0.231E-08    0.0          0.0          0.0
7     12068   H-3      0.235E-08    0.0          0.0          0.0
7     20113   RA-226   0.672E-12    0.672E-12    0.112E-12    0.784E-12
7     20113   PB-210   0.0          0.0          0.0          0.0
7     20113   PO-210   0.134E-11    0.134E-11    0.223E-12    0.157E-11
7     20113   RN-222   0.128E-08    0.0          0.0          0.0
7     20113   H-3      0.132E-08    0.0          0.0          0.0
7     32180   RA-226   0.251E-12    0.251E-12    0.594E-13    0.310E-12
7     32180   PB-210   0.0          0.0          0.0          0.0
7     32180   PO-210   0.502E-12    0.502E-12    0.119E-12    0.621E-12
7     32180   RN-222   0.739E-09    0.0          0.0          0.0
7     32180   H-3      0.781E-09    0.0          0.0          0.0
7     48270   RA-226   0.121E-12    0.121E-12    0.339E-13    0.155E-12
7     48270   PB-210   0.0          0.0          0.0          0.0
7     48270   PO-210   0.241E-12    0.241E-12    0.677E-13    0.309E-12
7     48270   RN-222   0.457E-09    0.0          0.0          0.0
7     48270   H-3      0.496E-09    0.0          0.0          0.0
7     64360   RA-226   0.563E-13    0.563E-13    0.211E-13    0.774E-13
7     64360   PB-210   0.0          0.0          0.0          0.0
7     64360   PO-210   0.113E-12    0.113E-12    0.421E-13    0.155E-12
7     64360   RN-222   0.322E-09    0.0          0.0          0.0
7     64360   H-3      0.359E-09    0.0          0.0          0.0
7     80450   RA-226   0.354E-13    0.354E-13    0.147E-13    0.501E-13
7     80450   PB-210   0.0          0.0          0.0          0.0
7     80450   PO-210   0.709E-13    0.709E-13    0.294E-13    0.100E-12
7     80450   RN-222   0.244E-09    0.0          0.0          0.0
7     80450   H-3      0.280E-09    0.0          0.0          0.0
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8      1207   RA-226   0.309E-09       0.309E-09       0.565E-11       0.315E-09
8      1207   PB-210   0.0             0.0             0.0             0.0
8      1207   PO-210   0.619E-09       0.619E-09       0.113E-10       0.630E-09
8      1207   RN-222   0.812E-07       0.0             0.0             0.0
8      1207   H-3      0.813E-07       0.0             0.0             0.0
8      2414   RA-226   0.585E-10       0.585E-10       0.183E-11       0.604E-10
8      2414   PB-210   0.0             0.0             0.0             0.0
8      2414   PO-210   0.117E-09       0.117E-09       0.365E-11       0.121E-09
8      2414   RN-222   0.202E-07       0.0             0.0             0.0
8      2414   H-3      0.203E-07       0.0             0.0             0.0
8      4023   RA-226   0.208E-10       0.208E-10       0.966E-12       0.217E-10
8      4023   PB-210   0.0             0.0             0.0             0.0
8      4023   PO-210   0.415E-10       0.415E-10       0.193E-11       0.435E-10
8      4023   RN-222   0.937E-08       0.0             0.0             0.0
8      4023   H-3      0.943E-08       0.0             0.0             0.0
8      5632   RA-226   0.110E-10       0.110E-10       0.645E-12       0.117E-10
8      5632   PB-210   0.0             0.0             0.0             0.0
8      5632   PO-210   0.221E-10       0.221E-10       0.129E-11       0.234E-10
8      5632   RN-222   0.584E-08       0.0             0.0             0.0
8      5632   H-3      0.589E-08       0.0             0.0             0.0
8      7241   RA-226   0.648E-11       0.648E-11       0.467E-12       0.695E-11
8      7241   PB-210   0.0             0.0             0.0             0.0
8      7241   PO-210   0.130E-10       0.130E-10       0.934E-12       0.139E-10
8      7241   RN-222   0.411E-08       0.0             0.0             0.0
8      7241   H-3      0.415E-08       0.0             0.0             0.0
8     12068   RA-226   0.249E-11       0.249E-11       0.251E-12       0.274E-11
8     12068   PB-210   0.0             0.0             0.0             0.0
8     12068   PO-210   0.498E-11       0.498E-11       0.503E-12       0.549E-11
8     12068   RN-222   0.210E-08       0.0             0.0             0.0
8     12068   H-3      0.214E-08       0.0             0.0             0.0
8     20113   RA-226   0.102E-11       0.102E-11       0.133E-12       0.115E-11
8     20113   PB-210   0.0             0.0             0.0             0.0
8     20113   PO-210   0.204E-11       0.204E-11       0.267E-12       0.231E-11
8     20113   RN-222   0.116E-08       0.0             0.0             0.0
8     20113   H-3      0.120E-08       0.0             0.0             0.0
8     32180   RA-226   0.403E-12       0.403E-12       0.711E-13       0.474E-12
8     32180   PB-210   0.0             0.0             0.0             0.0
8     32180   PO-210   0.806E-12       0.806E-12       0.142E-12       0.948E-12
8     32180   RN-222   0.673E-09       0.0             0.0             0.0
8     32180   H-3      0.706E-09       0.0             0.0             0.0
8     48270   RA-226   0.198E-12       0.198E-12       0.410E-13       0.239E-12
8     48270   PB-210   0.0             0.0             0.0             0.0
8     48270   PO-210   0.395E-12       0.395E-12       0.821E-13       0.477E-12
8     48270   RN-222   0.416E-09       0.0             0.0             0.0
8     48270   H-3      0.448E-09       0.0             0.0             0.0
8     64360   RA-226   0.896E-13       0.896E-13       0.254E-13       0.115E-12
8     64360   PB-210   0.0             0.0             0.0             0.0
8     64360   PO-210   0.179E-12       0.179E-12       0.507E-13       0.230E-12
8     64360   RN-222   0.294E-09       0.0             0.0             0.0
8     64360   H-3      0.324E-09       0.0             0.0             0.0
8     80450   RA-226   0.566E-13       0.566E-13       0.180E-13       0.745E-13
8     80450   PB-210   0.0             0.0             0.0             0.0
8     80450   PO-210   0.113E-12       0.113E-12       0.359E-13       0.149E-12
8     80450   RN-222   0.224E-09       0.0             0.0             0.0
8     80450   H-3      0.252E-09       0.0             0.0             0.0
9      1207   RA-226   0.416E-09       0.416E-09       0.809E-11       0.424E-09
9      1207   PB-210   0.0             0.0             0.0             0.0
9      1207   PO-210   0.831E-09       0.831E-09       0.162E-10       0.847E-09
9      1207   RN-222   0.993E-07       0.0             0.0             0.0
9      1207   H-3      0.995E-07       0.0             0.0             0.0
9      2414   RA-226   0.141E-09       0.141E-09       0.480E-11       0.146E-09
9      2414   PB-210   0.0             0.0             0.0             0.0
9      2414   PO-210   0.282E-09       0.282E-09       0.959E-11       0.291E-09
9      2414   RN-222   0.410E-07       0.0             0.0             0.0
9      2414   H-3      0.411E-07       0.0             0.0             0.0
9      4023   RA-226   0.519E-10       0.519E-10       0.260E-11       0.545E-10
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   9     4023   PB-210   0.0          0.0          0.0          0.0
   9     4023   PO-210   0.104E-09    0.104E-09    0.520E-11    0.109E-09
   9     4023   RN-222   0.189E-07    0.0          0.0          0.0
   9     4023   H-3      0.190E-07    0.0          0.0          0.0
   9     5632   RA-226   0.282E-10    0.282E-10    0.176E-11    0.299E-10
   9     5632   PB-210   0.0          0.0          0.0          0.0
   9     5632   PO-210   0.564E-10    0.564E-10    0.351E-11    0.599E-10
   9     5632   RN-222   0.117E-07    0.0          0.0          0.0
   9     5632   H-3      0.118E-07    0.0          0.0          0.0
   9     7241   RA-226   0.170E-10    0.170E-10    0.129E-11    0.183E-10
   9     7241   PB-210   0.0          0.0          0.0          0.0
   9     7241   PO-210   0.340E-10    0.340E-10    0.258E-11    0.366E-10
   9     7241   RN-222   0.823E-08    0.0          0.0          0.0
   9     7241   H-3      0.831E-08    0.0          0.0          0.0
   9    12068   RA-226   0.678E-11    0.678E-11    0.706E-12    0.748E-11
   9    12068   PB-210   0.0          0.0          0.0          0.0
   9    12068   PO-210   0.136E-10    0.136E-10    0.141E-11    0.150E-10
   9    12068   RN-222   0.418E-08    0.0          0.0          0.0
   9    12068   H-3      0.425E-08    0.0          0.0          0.0
   9    20113   RA-226   0.284E-11    0.284E-11    0.380E-12    0.322E-11
   9    20113   PB-210   0.0          0.0          0.0          0.0
   9    20113   PO-210   0.568E-11    0.568E-11    0.760E-12    0.644E-11
   9    20113   RN-222   0.230E-08    0.0          0.0          0.0
   9    20113   H-3      0.237E-08    0.0          0.0          0.0
   9    32180   RA-226   0.116E-11    0.116E-11    0.206E-12    0.137E-11
   9    32180   PB-210   0.0          0.0          0.0          0.0
   9    32180   PO-210   0.233E-11    0.233E-11    0.413E-12    0.274E-11
   9    32180   RN-222   0.133E-08    0.0          0.0          0.0
   9    32180   H-3      0.139E-08    0.0          0.0          0.0
   9    48270   RA-226   0.576E-12    0.576E-12    0.121E-12    0.697E-12
   9    48270   PB-210   0.0          0.0          0.0          0.0
   9    48270   PO-210   0.115E-11    0.115E-11    0.241E-12    0.139E-11
   9    48270   RN-222   0.819E-09    0.0          0.0          0.0
   9    48270   H-3      0.876E-09    0.0          0.0          0.0
   9    64360   RA-226   0.276E-12    0.276E-12    0.760E-13    0.352E-12
   9    64360   PB-210   0.0          0.0          0.0          0.0
   9    64360   PO-210   0.553E-12    0.553E-12    0.152E-12    0.705E-12
   9    64360   RN-222   0.578E-09    0.0          0.0          0.0
   9    64360   H-3      0.632E-09    0.0          0.0          0.0
   9    80450   RA-226   0.177E-12    0.177E-12    0.545E-13    0.231E-12
   9    80450   PB-210   0.0          0.0          0.0          0.0
   9    80450   PO-210   0.354E-12    0.354E-12    0.109E-12    0.463E-12
   9    80450   RN-222   0.439E-09    0.0          0.0          0.0
   9    80450   H-3      0.492E-09    0.0          0.0          0.0
  10     1207   RA-226   0.318E-09    0.318E-09    0.685E-11    0.325E-09
  10     1207   PB-210   0.0          0.0          0.0          0.0
  10     1207   PO-210   0.636E-09    0.636E-09    0.137E-10    0.650E-09
  10     1207   RN-222   0.752E-07    0.0          0.0          0.0
  10     1207   H-3      0.754E-07    0.0          0.0          0.0
  10     2414   RA-226   0.655E-10    0.655E-10    0.257E-11    0.681E-10
  10     2414   PB-210   0.0          0.0          0.0          0.0
  10     2414   PO-210   0.131E-09    0.131E-09    0.513E-11    0.136E-09
  10     2414   RN-222   0.193E-07    0.0          0.0          0.0
  10     2414   H-3      0.194E-07    0.0          0.0          0.0
  10     4023   RA-226   0.239E-10    0.239E-10    0.141E-11    0.253E-10
  10     4023   PB-210   0.0          0.0          0.0          0.0
  10     4023   PO-210   0.478E-10    0.478E-10    0.281E-11    0.506E-10
  10     4023   RN-222   0.889E-08    0.0          0.0          0.0
  10     4023   H-3      0.894E-08    0.0          0.0          0.0
  10     5632   RA-226   0.128E-10    0.128E-10    0.956E-12    0.138E-10
  10     5632   PB-210   0.0          0.0          0.0          0.0
  10     5632   PO-210   0.257E-10    0.257E-10    0.191E-11    0.276E-10
  10     5632   RN-222   0.551E-08    0.0          0.0          0.0
  10     5632   H-3      0.555E-08    0.0          0.0          0.0
  10     7241   RA-226   0.770E-11    0.770E-11    0.706E-12    0.840E-11
  10     7241   PB-210   0.0          0.0          0.0          0.0
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10      7241    PO-210    0.154E-10       0.154E-10       0.141E-11        0.168E-10
10      7241    RN-222    0.385E-08       0.0             0.0              0.0
10      7241    H-3       0.389E-08       0.0             0.0              0.0
10     12068    RA-226    0.301E-11       0.301E-11       0.391E-12        0.340E-11
10     12068    PB-210    0.0             0.0             0.0              0.0
10     12068    PO-210    0.603E-11       0.603E-11       0.782E-12        0.681E-11
10     12068    RN-222    0.195E-08       0.0             0.0              0.0
10     12068    H-3       0.198E-08       0.0             0.0              0.0
10     20113    RA-226    0.125E-11       0.125E-11       0.213E-12        0.146E-11
10     20113    PB-210    0.0             0.0             0.0              0.0
10     20113    PO-210    0.250E-11       0.250E-11       0.427E-12        0.292E-11
10     20113    RN-222    0.107E-08       0.0             0.0              0.0
10     20113    H-3       0.110E-08       0.0             0.0              0.0
10     32180    RA-226    0.510E-12       0.510E-12       0.118E-12        0.628E-12
10     32180    PB-210    0.0             0.0             0.0              0.0
10     32180    PO-210    0.102E-11       0.102E-11       0.236E-12        0.126E-11
10     32180    RN-222    0.616E-09       0.0             0.0              0.0
10     32180    H-3       0.645E-09       0.0             0.0              0.0
10     48270    RA-226    0.252E-12       0.252E-12       0.697E-13        0.322E-12
10     48270    PB-210    0.0             0.0             0.0              0.0
10     48270    PO-210    0.504E-12       0.504E-12       0.139E-12        0.643E-12
10     48270    RN-222    0.380E-09       0.0             0.0              0.0
10     48270    H-3       0.407E-09       0.0             0.0              0.0
10     64360    RA-226    0.126E-12       0.126E-12       0.452E-13        0.171E-12
10     64360    PB-210    0.0             0.0             0.0              0.0
10     64360    PO-210    0.252E-12       0.252E-12       0.904E-13        0.342E-12
10     64360    RN-222    0.268E-09       0.0             0.0              0.0
10     64360    H-3       0.294E-09       0.0             0.0              0.0
10     80450    RA-226    0.814E-13       0.814E-13       0.326E-13        0.114E-12
10     80450    PB-210    0.0             0.0             0.0              0.0
10     80450    PO-210    0.163E-12       0.163E-12       0.653E-13        0.228E-12
10     80450    RN-222    0.203E-09       0.0             0.0              0.0
10     80450    H-3       0.228E-09       0.0             0.0              0.0
11      1207    RA-226    0.214E-09       0.214E-09       0.547E-11        0.219E-09
11      1207    PB-210    0.0             0.0             0.0              0.0
11      1207    PO-210    0.427E-09       0.427E-09       0.109E-10        0.438E-09
11      1207    RN-222    0.518E-07       0.0             0.0              0.0
11      1207    H-3       0.519E-07       0.0             0.0              0.0
11      2414    RA-226    0.512E-10       0.512E-10       0.249E-11        0.537E-10
11      2414    PB-210    0.0             0.0             0.0              0.0
11      2414    PO-210    0.102E-09       0.102E-09       0.499E-11        0.107E-09
11      2414    RN-222    0.155E-07       0.0             0.0              0.0
11      2414    H-3       0.156E-07       0.0             0.0              0.0
11      4023    RA-226    0.186E-10       0.186E-10       0.139E-11        0.200E-10
11      4023    PB-210    0.0             0.0             0.0              0.0
11      4023    PO-210    0.372E-10       0.372E-10       0.277E-11        0.400E-10
11      4023    RN-222    0.708E-08       0.0             0.0              0.0
11      4023    H-3       0.713E-08       0.0             0.0              0.0
11      5632    RA-226    0.999E-11       0.999E-11       0.951E-12        0.109E-10
11      5632    PB-210    0.0             0.0             0.0              0.0
11      5632    PO-210    0.200E-10       0.200E-10       0.190E-11        0.219E-10
11      5632    RN-222    0.437E-08       0.0             0.0              0.0
11      5632    H-3       0.441E-08       0.0             0.0              0.0
11      7241    RA-226    0.603E-11       0.603E-11       0.709E-12        0.674E-11
11      7241    PB-210    0.0             0.0             0.0              0.0
11      7241    PO-210    0.121E-10       0.121E-10       0.142E-11        0.135E-10
11      7241    RN-222    0.305E-08       0.0             0.0              0.0
11      7241    H-3       0.308E-08       0.0             0.0              0.0
11     12068    RA-226    0.238E-11       0.238E-11       0.398E-12        0.277E-11
11     12068    PB-210    0.0             0.0             0.0              0.0
11     12068    PO-210    0.475E-11       0.475E-11       0.796E-12        0.555E-11
11     12068    RN-222    0.153E-08       0.0             0.0              0.0
11     12068    H-3       0.156E-08       0.0             0.0              0.0
11     20113    RA-226    0.100E-11       0.100E-11       0.220E-12        0.122E-11
11     20113    PB-210    0.0             0.0             0.0              0.0
11     20113    PO-210    0.200E-11       0.200E-11       0.440E-12        0.244E-11
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11     20113   RN-222   0.838E-09     0.0           0.0           0.0
11     20113   H-3      0.865E-09     0.0           0.0           0.0
11     32180   RA-226   0.429E-12     0.429E-12     0.123E-12     0.552E-12
11     32180   PB-210   0.0           0.0           0.0           0.0
11     32180   PO-210   0.858E-12     0.858E-12     0.247E-12     0.110E-11
11     32180   RN-222   0.480E-09     0.0           0.0           0.0
11     32180   H-3      0.505E-09     0.0           0.0           0.0
11     48270   RA-226   0.215E-12     0.215E-12     0.731E-13     0.288E-12
11     48270   PB-210   0.0           0.0           0.0           0.0
11     48270   PO-210   0.431E-12     0.431E-12     0.146E-12     0.577E-12
11     48270   RN-222   0.294E-09     0.0           0.0           0.0
11     48270   H-3      0.318E-09     0.0           0.0           0.0
11     64360   RA-226   0.115E-12     0.115E-12     0.480E-13     0.163E-12
11     64360   PB-210   0.0           0.0           0.0           0.0
11     64360   PO-210   0.230E-12     0.230E-12     0.960E-13     0.326E-12
11     64360   RN-222   0.207E-09     0.0           0.0           0.0
11     64360   H-3      0.229E-09     0.0           0.0           0.0
11     80450   RA-226   0.754E-13     0.754E-13     0.346E-13     0.110E-12
11     80450   PB-210   0.0           0.0           0.0           0.0
11     80450   PO-210   0.151E-12     0.151E-12     0.693E-13     0.220E-12
11     80450   RN-222   0.157E-09     0.0           0.0           0.0
11     80450   H-3      0.178E-09     0.0           0.0           0.0
12      1207   RA-226   0.181E-09     0.181E-09     0.518E-11     0.186E-09
12      1207   PB-210   0.0           0.0           0.0           0.0
12      1207   PO-210   0.362E-09     0.362E-09     0.104E-10     0.372E-09
12      1207   RN-222   0.445E-07     0.0           0.0           0.0
12      1207   H-3      0.446E-07     0.0           0.0           0.0
12      2414   RA-226   0.448E-10     0.448E-10     0.237E-11     0.472E-10
12      2414   PB-210   0.0           0.0           0.0           0.0
12      2414   PO-210   0.896E-10     0.896E-10     0.473E-11     0.944E-10
12      2414   RN-222   0.141E-07     0.0           0.0           0.0
12      2414   H-3      0.141E-07     0.0           0.0           0.0
12      4023   RA-226   0.163E-10     0.163E-10     0.132E-11     0.176E-10
12      4023   PB-210   0.0           0.0           0.0           0.0
12      4023   PO-210   0.326E-10     0.326E-10     0.265E-11     0.352E-10
12      4023   RN-222   0.641E-08     0.0           0.0           0.0
12      4023   H-3      0.645E-08     0.0           0.0           0.0
12      5632   RA-226   0.873E-11     0.873E-11     0.911E-12     0.964E-11
12      5632   PB-210   0.0           0.0           0.0           0.0
12      5632   PO-210   0.175E-10     0.175E-10     0.182E-11     0.193E-10
12      5632   RN-222   0.395E-08     0.0           0.0           0.0
12      5632   H-3      0.399E-08     0.0           0.0           0.0
12      7241   RA-226   0.528E-11     0.528E-11     0.682E-12     0.597E-11
12      7241   PB-210   0.0           0.0           0.0           0.0
12      7241   PO-210   0.106E-10     0.106E-10     0.136E-11     0.119E-10
12      7241   RN-222   0.275E-08     0.0           0.0           0.0
12      7241   H-3      0.279E-08     0.0           0.0           0.0
12     12068   RA-226   0.209E-11     0.209E-11     0.385E-12     0.248E-11
12     12068   PB-210   0.0           0.0           0.0           0.0
12     12068   PO-210   0.419E-11     0.419E-11     0.771E-12     0.496E-11
12     12068   RN-222   0.139E-08     0.0           0.0           0.0
12     12068   H-3      0.141E-08     0.0           0.0           0.0
12     20113   RA-226   0.891E-12     0.891E-12     0.215E-12     0.111E-11
12     20113   PB-210   0.0           0.0           0.0           0.0
12     20113   PO-210   0.178E-11     0.178E-11     0.429E-12     0.221E-11
12     20113   RN-222   0.757E-09     0.0           0.0           0.0
12     20113   H-3      0.783E-09     0.0           0.0           0.0
12     32180   RA-226   0.391E-12     0.391E-12     0.121E-12     0.512E-12
12     32180   PB-210   0.0           0.0           0.0           0.0
12     32180   PO-210   0.781E-12     0.781E-12     0.243E-12     0.102E-11
12     32180   RN-222   0.433E-09     0.0           0.0           0.0
12     32180   H-3      0.457E-09     0.0           0.0           0.0
12     48270   RA-226   0.198E-12     0.198E-12     0.724E-13     0.270E-12
12     48270   PB-210   0.0           0.0           0.0           0.0
12     48270   PO-210   0.396E-12     0.396E-12     0.145E-12     0.541E-12
12     48270   RN-222   0.266E-09     0.0           0.0           0.0
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12	48270	H-3	0.288E-09	0.0	0.0	0.0
12	64360	RA-226	0.108E-12	0.108E-12	0.480E-13	0.156E-12
12	64360	PB-210	0.0	0.0	0.0	0.0
12	64360	PO-210	0.215E-12	0.215E-12	0.960E-13	0.311E-12
12	64360	RN-222	0.187E-09	0.0	0.0	0.0
12	64360	H-3	0.208E-09	0.0	0.0	0.0
12	80450	RA-226	0.713E-13	0.713E-13	0.348E-13	0.106E-12
12	80450	PB-210	0.0	0.0	0.0	0.0
12	80450	PO-210	0.143E-12	0.143E-12	0.696E-13	0.212E-12
12	80450	RN-222	0.141E-09	0.0	0.0	0.0
12	80450	H-3	0.161E-09	0.0	0.0	0.0
13	1207	RA-226	0.163E-09	0.163E-09	0.499E-11	0.168E-09
13	1207	PB-210	0.0	0.0	0.0	0.0
13	1207	PO-210	0.326E-09	0.326E-09	0.998E-11	0.336E-09
13	1207	RN-222	0.390E-07	0.0	0.0	0.0
13	1207	H-3	0.391E-07	0.0	0.0	0.0
13	2414	RA-226	0.382E-10	0.382E-10	0.227E-11	0.404E-10
13	2414	PB-210	0.0	0.0	0.0	0.0
13	2414	PO-210	0.764E-10	0.764E-10	0.453E-11	0.809E-10
13	2414	RN-222	0.113E-07	0.0	0.0	0.0
13	2414	H-3	0.113E-07	0.0	0.0	0.0
13	4023	RA-226	0.139E-10	0.139E-10	0.128E-11	0.152E-10
13	4023	PB-210	0.0	0.0	0.0	0.0
13	4023	PO-210	0.279E-10	0.279E-10	0.255E-11	0.304E-10
13	4023	RN-222	0.511E-08	0.0	0.0	0.0
13	4023	H-3	0.514E-08	0.0	0.0	0.0
13	5632	RA-226	0.747E-11	0.747E-11	0.882E-12	0.836E-11
13	5632	PB-210	0.0	0.0	0.0	0.0
13	5632	PO-210	0.149E-10	0.149E-10	0.176E-11	0.167E-10
13	5632	RN-222	0.314E-08	0.0	0.0	0.0
13	5632	H-3	0.316E-08	0.0	0.0	0.0
13	7241	RA-226	0.454E-11	0.454E-11	0.664E-12	0.521E-11
13	7241	PB-210	0.0	0.0	0.0	0.0
13	7241	PO-210	0.908E-11	0.908E-11	0.133E-11	0.104E-10
13	7241	RN-222	0.218E-08	0.0	0.0	0.0
13	7241	H-3	0.221E-08	0.0	0.0	0.0
13	12068	RA-226	0.181E-11	0.181E-11	0.377E-12	0.218E-11
13	12068	PB-210	0.0	0.0	0.0	0.0
13	12068	PO-210	0.361E-11	0.361E-11	0.753E-12	0.437E-11
13	12068	RN-222	0.109E-08	0.0	0.0	0.0
13	12068	H-3	0.111E-08	0.0	0.0	0.0
13	20113	RA-226	0.778E-12	0.778E-12	0.211E-12	0.989E-12
13	20113	PB-210	0.0	0.0	0.0	0.0
13	20113	PO-210	0.156E-11	0.156E-11	0.421E-12	0.198E-11
13	20113	RN-222	0.595E-09	0.0	0.0	0.0
13	20113	H-3	0.615E-09	0.0	0.0	0.0
13	32180	RA-226	0.347E-12	0.347E-12	0.120E-12	0.466E-12
13	32180	PB-210	0.0	0.0	0.0	0.0
13	32180	PO-210	0.693E-12	0.693E-12	0.239E-12	0.932E-12
13	32180	RN-222	0.340E-09	0.0	0.0	0.0
13	32180	H-3	0.359E-09	0.0	0.0	0.0
13	48270	RA-226	0.177E-12	0.177E-12	0.716E-13	0.249E-12
13	48270	PB-210	0.0	0.0	0.0	0.0
13	48270	PO-210	0.354E-12	0.354E-12	0.143E-12	0.497E-12
13	48270	RN-222	0.209E-09	0.0	0.0	0.0
13	48270	H-3	0.226E-09	0.0	0.0	0.0
13	64360	RA-226	0.979E-13	0.979E-13	0.476E-13	0.145E-12
13	64360	PB-210	0.0	0.0	0.0	0.0
13	64360	PO-210	0.196E-12	0.196E-12	0.953E-13	0.291E-12
13	64360	RN-222	0.146E-09	0.0	0.0	0.0
13	64360	H-3	0.163E-09	0.0	0.0	0.0
13	80450	RA-226	0.651E-13	0.651E-13	0.346E-13	0.997E-13
13	80450	PB-210	0.0	0.0	0.0	0.0
13	80450	PO-210	0.130E-12	0.130E-12	0.692E-13	0.199E-12
13	80450	RN-222	0.111E-09	0.0	0.0	0.0
13	80450	H-3	0.127E-09	0.0	0.0	0.0

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14       1207    RA-226     0.172E-09          0.172E-09          0.530E-11          0.178E-09
14       1207    PB-210     0.0                0.0                0.0                0.0
14       1207    PO-210     0.345E-09          0.345E-09          0.106E-10          0.355E-09
14       1207    RN-222     0.399E-07          0.0                0.0                0.0
14       1207    H-3        0.400E-07          0.0                0.0                0.0
14       2414    RA-226     0.420E-10          0.420E-10          0.231E-11          0.443E-10
14       2414    PB-210     0.0                0.0                0.0                0.0
14       2414    PO-210     0.840E-10          0.840E-10          0.462E-11          0.886E-10
14       2414    RN-222     0.117E-07          0.0                0.0                0.0
14       2414    H-3        0.118E-07          0.0                0.0                0.0
14       4023    RA-226     0.155E-10          0.155E-10          0.130E-11          0.168E-10
14       4023    PB-210     0.0                0.0                0.0                0.0
14       4023    PO-210     0.310E-10          0.310E-10          0.260E-11          0.337E-10
14       4023    RN-222     0.532E-08          0.0                0.0                0.0
14       4023    H-3        0.535E-08          0.0                0.0                0.0
14       5632    RA-226     0.839E-11          0.839E-11          0.900E-12          0.929E-11
14       5632    PB-210     0.0                0.0                0.0                0.0
14       5632    PO-210     0.168E-10          0.168E-10          0.180E-11          0.186E-10
14       5632    RN-222     0.327E-08          0.0                0.0                0.0
14       5632    H-3        0.330E-08          0.0                0.0                0.0
14       7241    RA-226     0.513E-11          0.513E-11          0.677E-12          0.581E-11
14       7241    PB-210     0.0                0.0                0.0                0.0
14       7241    PO-210     0.103E-10          0.103E-10          0.135E-11          0.116E-10
14       7241    RN-222     0.228E-08          0.0                0.0                0.0
14       7241    H-3        0.230E-08          0.0                0.0                0.0
14      12068    RA-226     0.206E-11          0.206E-11          0.384E-12          0.244E-11
14      12068    PB-210     0.0                0.0                0.0                0.0
14      12068    PO-210     0.412E-11          0.412E-11          0.769E-12          0.489E-11
14      12068    RN-222     0.114E-08          0.0                0.0                0.0
14      12068    H-3        0.116E-08          0.0                0.0                0.0
14      20113    RA-226     0.884E-12          0.884E-12          0.215E-12          0.110E-11
14      20113    PB-210     0.0                0.0                0.0                0.0
14      20113    PO-210     0.177E-11          0.177E-11          0.430E-12          0.220E-11
14      20113    RN-222     0.620E-09          0.0                0.0                0.0
14      20113    H-3        0.639E-09          0.0                0.0                0.0
14      32180    RA-226     0.390E-12          0.390E-12          0.123E-12          0.513E-12
14      32180    PB-210     0.0                0.0                0.0                0.0
14      32180    PO-210     0.781E-12          0.781E-12          0.245E-12          0.103E-11
14      32180    RN-222     0.354E-09          0.0                0.0                0.0
14      32180    H-3        0.372E-09          0.0                0.0                0.0
14      48270    RA-226     0.199E-12          0.199E-12          0.740E-13          0.272E-12
14      48270    PB-210     0.0                0.0                0.0                0.0
14      48270    PO-210     0.397E-12          0.397E-12          0.148E-12          0.545E-12
14      48270    RN-222     0.217E-09          0.0                0.0                0.0
14      48270    H-3        0.234E-09          0.0                0.0                0.0
14      64360    RA-226     0.109E-12          0.109E-12          0.495E-13          0.158E-12
14      64360    PB-210     0.0                0.0                0.0                0.0
14      64360    PO-210     0.217E-12          0.217E-12          0.990E-13          0.316E-12
14      64360    RN-222     0.152E-09          0.0                0.0                0.0
14      64360    H-3        0.168E-09          0.0                0.0                0.0
14      80450    RA-226     0.722E-13          0.722E-13          0.363E-13          0.109E-12
14      80450    PB-210     0.0                0.0                0.0                0.0
14      80450    PO-210     0.144E-12          0.144E-12          0.725E-13          0.217E-12
14      80450    RN-222     0.115E-09          0.0                0.0                0.0
14      80450    H-3        0.131E-09          0.0                0.0                0.0
15       1207    RA-226     0.187E-09          0.187E-09          0.569E-11          0.192E-09
15       1207    PB-210     0.0                0.0                0.0                0.0
15       1207    PO-210     0.373E-09          0.373E-09          0.114E-10          0.385E-09
15       1207    RN-222     0.429E-07          0.0                0.0                0.0
15       1207    H-3        0.429E-07          0.0                0.0                0.0
15       2414    RA-226     0.511E-10          0.511E-10          0.295E-11          0.541E-10
15       2414    PB-210     0.0                0.0                0.0                0.0
15       2414    PO-210     0.102E-09          0.102E-09          0.590E-11          0.108E-09
15       2414    RN-222     0.146E-07          0.0                0.0                0.0
15       2414    H-3        0.147E-07          0.0                0.0                0.0
15       4023    RA-226     0.188E-10          0.188E-10          0.166E-11          0.205E-10
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15     4023   PB-210   0.0         0.0         0.0         0.0
15     4023   PO-210   0.377E-10   0.377E-10   0.333E-11   0.410E-10
15     4023   RN-222   0.662E-08   0.0         0.0         0.0
15     4023   H-3      0.666E-08   0.0         0.0         0.0
15     5632   RA-226   0.101E-10   0.101E-10   0.115E-11   0.113E-10
15     5632   PB-210   0.0         0.0         0.0         0.0
15     5632   PO-210   0.203E-10   0.203E-10   0.230E-11   0.226E-10
15     5632   RN-222   0.406E-08   0.0         0.0         0.0
15     5632   H-3      0.410E-08   0.0         0.0         0.0
15     7241   RA-226   0.620E-11   0.620E-11   0.865E-12   0.707E-11
15     7241   PB-210   0.0         0.0         0.0         0.0
15     7241   PO-210   0.124E-10   0.124E-10   0.173E-11   0.141E-10
15     7241   RN-222   0.282E-08   0.0         0.0         0.0
15     7241   H-3      0.286E-08   0.0         0.0         0.0
15    12068   RA-226   0.248E-11   0.248E-11   0.491E-12   0.297E-11
15    12068   PB-210   0.0         0.0         0.0         0.0
15    12068   PO-210   0.496E-11   0.496E-11   0.982E-12   0.594E-11
15    12068   RN-222   0.141E-08   0.0         0.0         0.0
15    12068   H-3      0.144E-08   0.0         0.0         0.0
15    20113   RA-226   0.106E-11   0.106E-11   0.275E-12   0.134E-11
15    20113   PB-210   0.0         0.0         0.0         0.0
15    20113   PO-210   0.213E-11   0.213E-11   0.549E-12   0.268E-11
15    20113   RN-222   0.766E-09   0.0         0.0         0.0
15    20113   H-3      0.791E-09   0.0         0.0         0.0
15    32180   RA-226   0.472E-12   0.472E-12   0.156E-12   0.628E-12
15    32180   PB-210   0.0         0.0         0.0         0.0
15    32180   PO-210   0.945E-12   0.945E-12   0.312E-12   0.126E-11
15    32180   RN-222   0.436E-09   0.0         0.0         0.0
15    32180   H-3      0.460E-09   0.0         0.0         0.0
15    48270   RA-226   0.239E-12   0.239E-12   0.937E-13   0.333E-12
15    48270   PB-210   0.0         0.0         0.0         0.0
15    48270   PO-210   0.478E-12   0.478E-12   0.187E-12   0.666E-12
15    48270   RN-222   0.267E-09   0.0         0.0         0.0
15    48270   H-3      0.289E-09   0.0         0.0         0.0
15    64360   RA-226   0.130E-12   0.130E-12   0.625E-13   0.193E-12
15    64360   PB-210   0.0         0.0         0.0         0.0
15    64360   PO-210   0.261E-12   0.261E-12   0.125E-12   0.386E-12
15    64360   RN-222   0.187E-09   0.0         0.0         0.0
15    64360   H-3      0.208E-09   0.0         0.0         0.0
15    80450   RA-226   0.861E-13   0.861E-13   0.456E-13   0.132E-12
15    80450   PB-210   0.0         0.0         0.0         0.0
15    80450   PO-210   0.172E-12   0.172E-12   0.912E-13   0.263E-12
15    80450   RN-222   0.141E-09   0.0         0.0         0.0
15    80450   H-3      0.161E-09   0.0         0.0         0.0
16     1207   RA-226   0.219E-09   0.219E-09   0.599E-11   0.225E-09
16     1207   PB-210   0.0         0.0         0.0         0.0
16     1207   PO-210   0.437E-09   0.437E-09   0.120E-10   0.449E-09
16     1207   RN-222   0.525E-07   0.0         0.0         0.0
16     1207   H-3      0.526E-07   0.0         0.0         0.0
16     2414   RA-226   0.426E-10   0.426E-10   0.221E-11   0.448E-10
16     2414   PB-210   0.0         0.0         0.0         0.0
16     2414   PO-210   0.852E-10   0.852E-10   0.443E-11   0.896E-10
16     2414   RN-222   0.114E-07   0.0         0.0         0.0
16     2414   H-3      0.114E-07   0.0         0.0         0.0
16     4023   RA-226   0.159E-10   0.159E-10   0.125E-11   0.172E-10
16     4023   PB-210   0.0         0.0         0.0         0.0
16     4023   PO-210   0.319E-10   0.319E-10   0.250E-11   0.344E-10
16     4023   RN-222   0.517E-08   0.0         0.0         0.0
16     4023   H-3      0.520E-08   0.0         0.0         0.0
16     5632   RA-226   0.869E-11   0.869E-11   0.863E-12   0.955E-11
16     5632   PB-210   0.0         0.0         0.0         0.0
16     5632   PO-210   0.174E-10   0.174E-10   0.173E-11   0.191E-10
16     5632   RN-222   0.318E-08   0.0         0.0         0.0
16     5632   H-3      0.320E-08   0.0         0.0         0.0
16     7241   RA-226   0.536E-11   0.536E-11   0.649E-12   0.601E-11
16     7241   PB-210   0.0         0.0         0.0         0.0
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16        7241    PO-210    0.107E-10    0.107E-10    0.130E-11    0.120E-10
16        7241    RN-222    0.221E-08    0.0          0.0          0.0
16        7241    H-3       0.224E-08    0.0          0.0          0.0
16       12068    RA-226    0.218E-11    0.218E-11    0.368E-12    0.254E-11
16       12068    PB-210    0.0          0.0          0.0          0.0
16       12068    PO-210    0.435E-11    0.435E-11    0.737E-12    0.509E-11
16       12068    RN-222    0.111E-08    0.0          0.0          0.0
16       12068    H-3       0.113E-08    0.0          0.0          0.0
16       20113    RA-226    0.940E-12    0.940E-12    0.206E-12    0.115E-11
16       20113    PB-210    0.0          0.0          0.0          0.0
16       20113    PO-210    0.188E-11    0.188E-11    0.413E-12    0.229E-11
16       20113    RN-222    0.601E-09    0.0          0.0          0.0
16       20113    H-3       0.620E-09    0.0          0.0          0.0
16       32180    RA-226    0.416E-12    0.416E-12    0.118E-12    0.533E-12
16       32180    PB-210    0.0          0.0          0.0          0.0
16       32180    PO-210    0.831E-12    0.831E-12    0.236E-12    0.137E-11
16       32180    RN-222    0.343E-09    0.0          0.0          0.0
16       32180    H-3       0.360E-09    0.0          0.0          0.0
16       48270    RA-226    0.211E-12    0.211E-12    0.713E-13    0.282E-12
16       48270    PB-210    0.0          0.0          0.0          0.0
16       48270    PO-210    0.421E-12    0.421E-12    0.143E-12    0.564E-12
16       48270    RN-222    0.210E-09    0.0          0.0          0.0
16       48270    H-3       0.226E-09    0.0          0.0          0.0
16       64360    RA-226    0.113E-12    0.113E-12    0.478E-13    0.161E-12
16       64360    PB-210    0.0          0.0          0.0          0.0
16       64360    PO-210    0.227E-12    0.227E-12    0.956E-13    0.323E-12
16       64360    RN-222    0.147E-09    0.0          0.0          0.0
16       64360    H-3       0.163E-09    0.0          0.0          0.0
16       80450    RA-226    0.751E-13    0.751E-13    0.352E-13    0.110E-12
16       80450    PB-210    0.0          0.0          0.0          0.0
16       80450    PO-210    0.150E-12    0.150E-12    0.704E-13    0.221E-12
16       80450    RN-222    0.111E-09    0.0          0.0          0.0
16       80450    H-3       0.126E-09    0.0          0.0          0.0
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GROUND-LEVEL CHI/Q VALUES FOR RA-226 AT VARIOUS DISTANCES IN EACH COMPASS DIRECTION

DISTANCE (METERS)	CHI/Q TOWARD INDICATED DIRECTION (SEC/CUBIC METER)							
	N	NNW	NW	WNW	W	WSW	SW	SSW
1207	0.921E-06	0.107E-05	0.127E-05	0.110E-05	0.684E-06	0.518E-06	0.640E-06	0.976E-06
2414	0.272E-06	0.210E-06	0.349E-06	0.280E-06	0.147E-06	0.951E-07	0.158E-06	0.185E-06
4023	0.977E-07	0.730E-07	0.120E-06	0.991E-07	0.534E-07	0.324E-07	0.527E-07	0.655E-07
5632	0.522E-07	0.383E-07	0.625E-07	0.527E-07	0.290E-07	0.169E-07	0.271E-07	0.348E-07
7241	0.312E-07	0.220E-07	0.356E-07	0.310E-07	0.176E-07	0.976E-08	0.152E-07	0.204E-07
12068	0.122E-07	0.821E-08	0.131E-07	0.119E-07	0.703E-08	0.367E-08	0.548E-08	0.786E-08
20113	0.509E-08	0.323E-08	0.504E-08	0.478E-08	0.292E-08	0.147E-08	0.212E-08	0.322E-08
32180	0.214E-08	0.121E-08	0.181E-08	0.187E-08	0.124E-08	0.592E-09	0.792E-09	0.127E-08
48270	0.106E-08	0.579E-09	0.852E-09	0.912E-09	0.615E-09	0.289E-09	0.381E-09	0.623E-09
64360	0.550E-09	0.265E-09	0.370E-09	0.448E-09	0.330E-09	0.142E-09	0.178E-09	0.283E-09
80450	0.357E-09	0.167E-09	0.230E-09	0.289E-09	0.217E-09	0.909E-10	0.112E-09	0.178E-09

	S	SSE	SE	ESE	E	ENE	NE	NNE
1207	0.131E-05	0.100E-05	0.674E-06	0.570E-06	0.515E-06	0.544E-06	0.544E-06	0.689E-06
2414	0.444E-06	0.207E-06	0.161E-06	0.141E-06	0.120E-06	0.132E-06	0.132E-06	0.134E-06
4023	0.164E-06	0.753E-07	0.587E-07	0.513E-07	0.439E-07	0.490E-07	0.490E-07	0.503E-07
5632	0.889E-07	0.405E-07	0.315E-07	0.275E-07	0.236E-07	0.265E-07	0.265E-07	0.274E-07
7241	0.536E-07	0.243E-07	0.190E-07	0.167E-07	0.143E-07	0.162E-07	0.162E-07	0.169E-07
12068	0.214E-07	0.950E-08	0.749E-08	0.660E-08	0.570E-08	0.649E-08	0.649E-08	0.686E-08
20113	0.896E-08	0.394E-08	0.315E-08	0.281E-08	0.245E-08	0.279E-08	0.279E-08	0.296E-08
32180	0.367E-08	0.161E-08	0.135E-08	0.123E-08	0.109E-08	0.123E-08	0.123E-08	0.131E-08
48270	0.182E-08	0.794E-09	0.679E-09	0.624E-09	0.558E-09	0.626E-09	0.626E-09	0.664E-09
64360	0.872E-09	0.398E-09	0.362E-09	0.340E-09	0.309E-09	0.343E-09	0.343E-09	0.358E-09
80450	0.558E-09	0.257E-09	0.238E-09	0.225E-09	0.205E-09	0.228E-09	0.228E-09	0.237E-09

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     GROUND-LEVEL CHI/Q VALUES FOR PB-210  AT VARIOUS DISTANCES IN EACH COMPASS DIRECTION

DISTANCE                               CHI/Q TOWARD INDICATED DIRECTION
(METERS)                                     (SEC/CUBIC METER)

              N          NNW         NW         WNW          W          WSW         SW          SSW

  1207     0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0
  2414     0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0
  4023     0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0
  5632     0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0
  7241     0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0
 12068     0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0
 20113     0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0
 32180     0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0
 48270     0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0
 64360     0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0
 80450     0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0


              S          SSE         SE         ESE          E          ENE         NE          NNE

  1207     0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0
  2414     0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0
  4023     0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0
  5632     0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0
  7241     0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0
 12068     0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0
 20113     0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0
 32180     0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0
 48270     0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0
 64360     0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0
 80450     0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0
```

GROUND-LEVEL CHI/Q VALUES FOR PO-210 AT VARIOUS DISTANCES IN EACH COMPASS DIRECTION

CHI/Q TOWARD INDICATED DIRECTION
(SEC/CUBIC METER)

DISTANCE (METERS)	N	NNW	NW	WNW	W	WSW	SW	SSW
1207	0.921E-06	0.107E-05	0.127E-05	0.110E-05	0.684E-06	0.518E-06	0.640E-06	0.976E-06
2414	0.272E-06	0.210E-06	0.349E-06	0.280E-06	0.147E-06	0.951E-07	0.158E-06	0.185E-06
4023	0.977E-07	0.730E-07	0.120E-06	0.991E-07	0.534E-07	0.324E-07	0.527E-07	0.655E-07
5632	0.522E-07	0.383E-07	0.625E-07	0.527E-07	0.290E-07	0.169E-07	0.271E-07	0.348E-07
7241	0.312E-07	0.220E-07	0.356E-07	0.310E-07	0.176E-07	0.976E-08	0.152E-07	0.204E-07
12068	0.122E-07	0.821E-08	0.131E-07	0.119E-07	0.703E-08	0.367E-08	0.548E-08	0.786E-08
20113	0.509E-08	0.323E-08	0.504E-08	0.478E-08	0.292E-08	0.147E-08	0.212E-08	0.322E-08
32180	0.214E-08	0.121E-08	0.181E-08	0.187E-08	0.124E-08	0.592E-09	0.792E-09	0.127E-08
48270	0.106E-08	0.579E-09	0.852E-09	0.912E-09	0.615E-09	0.289E-09	0.381E-09	0.623E-09
64360	0.550E-09	0.265E-09	0.370E-09	0.448E-09	0.330E-09	0.142E-09	0.178E-09	0.283E-09
80450	0.357E-09	0.167E-09	0.230E-09	0.289E-09	0.217E-09	0.909E-10	0.112E-09	0.178E-09

DISTANCE (METERS)	S	SSE	SE	ESE	E	ENE	NE	NNE
1207	0.131E-05	0.100E-05	0.674E-06	0.570E-06	0.515E-06	0.544E-06	0.544E-06	0.689E-06
2414	0.444E-06	0.207E-06	0.161E-06	0.141E-06	0.120E-06	0.132E-06	0.132E-06	0.134E-06
4023	0.164E-06	0.753E-07	0.587E-07	0.513E-07	0.439E-07	0.490E-07	0.490E-07	0.503E-07
5632	0.889E-07	0.405E-07	0.315E-07	0.275E-07	0.236E-07	0.265E-07	0.265E-07	0.274E-07
7241	0.536E-07	0.243E-07	0.190E-07	0.167E-07	0.143E-07	0.162E-07	0.162E-07	0.169E-07
12068	0.214E-07	0.950E-08	0.749E-08	0.660E-08	0.570E-08	0.649E-08	0.649E-08	0.686E-08
20113	0.896E-08	0.394E-08	0.315E-08	0.281E-08	0.245E-08	0.279E-08	0.279E-08	0.296E-08
32180	0.367E-08	0.161E-08	0.135E-08	0.123E-08	0.109E-08	0.123E-08	0.123E-08	0.131E-08
48270	0.182E-08	0.794E-09	0.679E-09	0.624E-09	0.558E-09	0.626E-09	0.626E-09	0.664E-09
64360	0.872E-09	0.398E-09	0.362E-09	0.340E-09	0.309E-09	0.343E-09	0.343E-09	0.358E-09
80450	0.558E-09	0.257E-09	0.238E-09	0.225E-09	0.205E-09	0.228E-09	0.228E-09	0.237E-09

GROUND-LEVEL CHI/Q VALUES FOR RN-222 AT VARIOUS DISTANCES IN EACH COMPASS DIRECTION

DISTANCE (METERS)	CHI/Q TOWARD INDICATED DIRECTION (SEC/CUBIC METER)							
	N	NNW	NW	WNW	W	WSW	SW	SSW
1207	0.242E-05	0.301E-05	0.364E-05	0.315E-05	0.199E-05	0.163E-05	0.197E-05	0.256E-05
2414	0.917E-06	0.777E-06	0.136E-05	0.104E-05	0.534E-06	0.426E-06	0.697E-06	0.638E-06
4023	0.421E-06	0.360E-06	0.633E-06	0.482E-06	0.248E-06	0.198E-06	0.324E-06	0.296E-06
5632	0.261E-06	0.225E-06	0.396E-06	0.301E-06	0.154E-06	0.123E-06	0.202E-06	0.184E-06
7241	0.183E-06	0.158E-06	0.279E-06	0.212E-06	0.108E-06	0.866E-07	0.142E-06	0.129E-06
12068	0.923E-07	0.808E-07	0.143E-06	0.108E-06	0.551E-07	0.443E-07	0.727E-07	0.662E-07
20113	0.506E-07	0.448E-07	0.794E-07	0.599E-07	0.302E-07	0.245E-07	0.403E-07	0.367E-07
32180	0.290E-07	0.259E-07	0.460E-07	0.346E-07	0.173E-07	0.141E-07	0.233E-07	0.212E-07
48270	0.178E-07	0.160E-07	0.285E-07	0.213E-07	0.106E-07	0.867E-08	0.144E-07	0.131E-07
64360	0.125E-07	0.113E-07	0.201E-07	0.150E-07	0.743E-08	0.610E-08	0.102E-07	0.928E-08
80450	0.947E-08	0.858E-08	0.153E-07	0.114E-07	0.562E-08	0.461E-08	0.769E-08	0.705E-08

	S	SSE	SE	ESE	E	ENE	NE	NNE
1207	0.313E-05	0.237E-05	0.163E-05	0.140E-05	0.123E-05	0.126E-05	0.126E-05	0.166E-05
2414	0.129E-05	0.610E-06	0.489E-06	0.443E-06	0.355E-06	0.370E-06	0.370E-06	0.359E-06
4023	0.596E-06	0.280E-06	0.223E-06	0.202E-06	0.161E-06	0.168E-06	0.168E-06	0.163E-06
5632	0.370E-06	0.174E-06	0.138E-06	0.125E-06	0.989E-07	0.103E-06	0.103E-06	0.100E-06
7241	0.260E-06	0.122E-06	0.961E-07	0.869E-07	0.688E-07	0.718E-07	0.718E-07	0.697E-07
12068	0.132E-06	0.615E-07	0.484E-07	0.437E-07	0.344E-07	0.359E-07	0.359E-07	0.349E-07
20113	0.726E-07	0.338E-07	0.264E-07	0.239E-07	0.188E-07	0.195E-07	0.195E-07	0.190E-07
32180	0.418E-07	0.194E-07	0.151E-07	0.137E-07	0.107E-07	0.112E-07	0.112E-07	0.108E-07
48270	0.258E-07	0.120E-07	0.929E-08	0.838E-08	0.658E-08	0.683E-08	0.683E-08	0.662E-08
64360	0.182E-07	0.845E-08	0.653E-08	0.588E-08	0.461E-08	0.479E-08	0.479E-08	0.464E-08
80450	0.139E-07	0.641E-08	0.494E-08	0.444E-08	0.349E-08	0.362E-08	0.362E-08	0.351E-08

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     GROUND-LEVEL CHI/Q VALUES FOR H-3     AT VARIOUS DISTANCES IN EACH COMPASS DIRECTION

DISTANCE                             CHI/Q TOWARD INDICATED DIRECTION
(METERS)                                    (SEC/CUBIC METER)

              N          NNW         NW         WNW          W          WSW         SW         SSW

  1207   0.242E-05  0.301E-05  0.365E-05  0.316E-05  0.199E-05  0.164E-05  0.197E-05  0.256E-05
  2414   0.921E-06  0.780E-06  0.137E-05  0.104E-05  0.536E-06  0.428E-06  0.699E-06  0.640E-06
  4023   0.424E-06  0.363E-06  0.637E-06  0.485E-06  0.249E-06  0.199E-06  0.326E-06  0.297E-06
  5632   0.263E-06  0.227E-06  0.399E-06  0.304E-06  0.156E-06  0.125E-06  0.204E-06  0.186E-06
  7241   0.185E-06  0.160E-06  0.282E-06  0.214E-06  0.110E-06  0.878E-07  0.144E-06  0.131E-06
 12068   0.942E-07  0.823E-07  0.146E-06  0.110E-06  0.562E-07  0.452E-07  0.742E-07  0.674E-07
 20113   0.523E-07  0.462E-07  0.819E-07  0.618E-07  0.312E-07  0.254E-07  0.418E-07  0.378E-07
 32180   0.306E-07  0.272E-07  0.483E-07  0.363E-07  0.183E-07  0.149E-07  0.246E-07  0.223E-07
 48270   0.193E-07  0.172E-07  0.307E-07  0.230E-07  0.115E-07  0.947E-08  0.156E-07  0.141E-07
 64360   0.140E-07  0.125E-07  0.222E-07  0.166E-07  0.830E-08  0.686E-08  0.113E-07  0.102E-07
 80450   0.108E-07  0.972E-08  0.173E-07  0.130E-07  0.645E-08  0.534E-08  0.883E-08  0.796E-08


              S          SSE         SE         ESE          E          ENE         NE         NNE

  1207   0.314E-05  0.238E-05  0.164E-05  0.141E-05  0.123E-05  0.126E-05  0.126E-05  0.166E-05
  2414   0.130E-05  0.612E-06  0.491E-06  0.445E-06  0.357E-06  0.371E-06  0.371E-06  0.361E-06
  4023   0.599E-06  0.282E-06  0.225E-06  0.203E-06  0.162E-06  0.169E-06  0.169E-06  0.164E-06
  5632   0.373E-06  0.175E-06  0.139E-06  0.126E-06  0.998E-07  0.104E-06  0.104E-06  0.101E-06
  7241   0.262E-06  0.123E-06  0.972E-07  0.879E-07  0.696E-07  0.725E-07  0.725E-07  0.705E-07
 12068   0.134E-06  0.626E-07  0.493E-07  0.446E-07  0.351E-07  0.366E-07  0.366E-07  0.355E-07
 20113   0.747E-07  0.348E-07  0.273E-07  0.247E-07  0.194E-07  0.202E-07  0.202E-07  0.196E-07
 32180   0.437E-07  0.204E-07  0.159E-07  0.144E-07  0.113E-07  0.117E-07  0.117E-07  0.114E-07
 48270   0.276E-07  0.128E-07  0.100E-07  0.908E-08  0.713E-08  0.737E-08  0.737E-08  0.713E-08
 64360   0.199E-07  0.927E-08  0.723E-08  0.655E-08  0.514E-08  0.531E-08  0.531E-08  0.513E-08
 80450   0.155E-07  0.720E-08  0.561E-08  0.509E-08  0.399E-08  0.412E-08  0.412E-08  0.398E-08
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                    OPTIONS SELECTED FOR DOSE AND INTAKE CALCULATIONS

CALCULATIONS ARE MADE FOR THE POPULATION.
TABLES FOR EACH NUCLIDE LISTING DOSES BY ORGAN AND PATHWAY AT EACH ENVIRONMENTAL LOCATION ARE OMITTED.
ENVIRONMENTAL CONCENTRATIONS AND INTAKE RATES BY MAN FOR EACH NUCLIDE ARE PRINTED AND WRITTEN UNFORMATTED.
DOSE SUMMARY TABLES ARE PRINTED
WORKING LEVELS ARE CALCULATED FOR RN-222 IF IT IS IN THE SOURCE TERM
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SUMMARY OF AREA SURROUNDING PLANT

AREA COLUMN	AREA ROW	NO. MEAT ANIMALS	NO. MILK CATTLE	FOOD CROPS (SQUARE METERS)	WATER AREA	POPULATION
1	1	10000	10000	0.100E 21	0	0.0
1	2	10000	10000	0.100E 21	0	0.0
1	3	10000	10000	0.100E 21	0	0.0
1	4	10000	10000	0.100E 21	0	0.0
1	5	10000	10000	0.100E 21	0	0.0
1	6	10000	10000	0.100E 21	0	38.0
1	7	10000	10000	0.100E 21	0	0.0
1	8	10000	10000	0.100E 21	0	0.0
1	9	10000	10000	0.100E 21	0	5.0
1	10	10000	10000	0.100E 21	0	306.0
1	11	10000	10000	0.100E 21	0	2330.0
1	12	10000	10000	0.100E 21	0	0.0
1	13	10000	10000	0.100E 21	0	0.0
1	14	10000	10000	0.100E 21	0	0.0
1	15	10000	10000	0.100E 21	0	0.0
1	16	10000	10000	0.100E 21	0	0.0
1	17	10000	10000	0.100E 21	0	0.0
1	18	10000	10000	0.100E 21	0	0.0
1	19	10000	10000	0.100E 21	0	0.0
1	20	10000	10000	0.100E 21	0	0.0
2	1	10000	10000	0.100E 21	0	0.0
2	2	10000	10000	0.100E 21	0	0.0
2	3	10000	10000	0.100E 21	0	0.0
2	4	10000	10000	0.100E 21	0	0.0
2	5	10000	10000	0.100E 21	0	0.0
2	6	10000	10000	0.100E 21	0	0.0
2	7	10000	10000	0.100E 21	0	197.0
2	8	10000	10000	0.100E 21	0	91.0
2	9	10000	10000	0.100E 21	0	410.0
2	10	10000	10000	0.100E 21	0	197.0
2	11	10000	10000	0.100E 21	0	181.0
2	12	10000	10000	0.100E 21	0	0.0
2	13	10000	10000	0.100E 21	0	0.0
2	14	10000	10000	0.100E 21	0	0.0
2	15	10000	10000	0.100E 21	0	0.0
2	16	10000	10000	0.100E 21	0	0.0
2	17	10000	10000	0.100E 21	0	0.0
2	18	10000	10000	0.100E 21	0	0.0
2	19	10000	10000	0.100E 21	0	0.0
2	20	10000	10000	0.100E 21	0	0.0
3	1	10000	10000	0.100E 21	0	0.0
3	2	10000	10000	0.100E 21	0	0.0
3	3	10000	10000	0.100E 21	0	0.0
3	4	10000	10000	0.100E 21	0	0.0
3	5	10000	10000	0.100E 21	0	0.0
3	6	10000	10000	0.100E 21	0	0.0
3	7	10000	10000	0.100E 21	0	0.0
3	8	10000	10000	0.100E 21	0	0.0
3	9	10000	10000	0.100E 21	0	643.0

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 3   10        10000      10000    0.100E 21     0      858.0
 3   11        10000      10000    0.100E 21     0      365.0
 3   12        10000      10000    0.100E 21     0        0.0
 3   13        10000      10000    0.100E 21     0        0.0
 3   14        10000      10000    0.100E 21     0        0.0
 3   15        10000      10000    0.100E 21     0        0.0
 3   16        10000      10000    0.100E 21     0        0.0
 3   17        10000      10000    0.100E 21     0        0.0
 3   18        10000      10000    0.100E 21     0        0.0
 3   19        10000      10000    0.100E 21     0        0.0
 3   20        10000      10000    0.100E 21     0        0.0
 4    1        10000      10000    0.100E 21     0        0.0
 4    2        10000      10000    0.100E 21     0        0.0
 4    3        10000      10000    0.100E 21     0        0.0
 4    4        10000      10000    0.100E 21     0        0.0
 4    5        10000      10000    0.100E 21     0        0.0
 4    6        10000      10000    0.100E 21     0        0.0
 4    7        10000      10000    0.100E 21     0      102.0
 4    8        10000      10000    0.100E 21     0      135.0
 4    9        10000      10000    0.100E 21     0      338.0
 4   10        10000      10000    0.100E 21     0     2954.0
 4   11        10000      10000    0.100E 21     0     4881.0
 4   12        10000      10000    0.100E 21     0        0.0
 4   13        10000      10000    0.100E 21     0        0.0
 4   14        10000      10000    0.100E 21     0        0.0
 4   15        10000      10000    0.100E 21     0        0.0
 4   16        10000      10000    0.100E 21     0        0.0
 4   17        10000      10000    0.100E 21     0        0.0
 4   18        10000      10000    0.100E 21     0        0.0
 4   19        10000      10000    0.100E 21     0        0.0
 4   20        10000      10000    0.100E 21     0        0.0
 5    1        10000      10000    0.100E 21     0        0.0
 5    2        10000      10000    0.100E 21     0        0.0
 5    3        10000      10000    0.100E 21     0        0.0
 5    4        10000      10000    0.100E 21     0        0.0
 5    5        10000      10000    0.100E 21     0        0.0
 5    6        10000      10000    0.100E 21     0       97.0
 5    7        10000      10000    0.100E 21     0      197.0
 5    8        10000      10000    0.100E 21     0        0.0
 5    9        10000      10000    0.100E 21     0       79.0
 5   10        10000      10000    0.100E 21     0       69.0
 5   11        10000      10000    0.100E 21     0     4185.0
 5   12        10000      10000    0.100E 21     0        0.0
 5   13        10000      10000    0.100E 21     0        0.0
 5   14        10000      10000    0.100E 21     0        0.0
 5   15        10000      10000    0.100E 21     0        0.0
 5   16        10000      10000    0.100E 21     0        0.0
 5   17        10000      10000    0.100E 21     0        0.0
 5   18        10000      10000    0.100E 21     0        0.0
 5   19        10000      10000    0.100E 21     0        0.0
 5   20        10000      10000    0.100E 21     0        0.0
 6    1        10000      10000    0.100E 21     0        0.0
 6    2        10000      10000    0.100E 21     0      191.0
 6    3        10000      10000    0.100E 21     0        0.0
 6    4        10000      10000    0.100E 21     0        0.0
 6    5        10000      10000    0.100E 21     0        0.0
 6    6        10000      10000    0.100E 21     0        0.0
 6    7        10000      10000    0.100E 21     0        0.0
 6    8        10000      10000    0.100E 21     0      168.0
 6    9        10000      10000    0.100E 21     0      181.0
 6   10        10000      10000    0.100E 21     0     5578.0
 6   11        10000      10000    0.100E 21     0     5226.0
 6   12        10000      10000    0.100E 21     0        0.0
 6   13        10000      10000    0.100E 21     0        0.0
 6   14        10000      10000    0.100E 21     0        0.0
 6   15        10000      10000    0.100E 21     0        0.0
 6   16     10000     10000     0.100E 21     0        0.0
 6   17     10000     10000     0.100E 21     0        0.0
 6   18     10000     10000     0.100E 21     0        0.0
 6   19     10000     10000     0.100E 21     0        0.0
 6   20     10000     10000     0.100E 21     0        0.0
 7    1     10000     10000     0.100E 21     0        0.0
 7    2     10000     10000     0.100E 21     0        0.0
 7    3     10000     10000     0.100E 21     0        0.0
 7    4     10000     10000     0.100E 21     0        0.0
 7    5     10000     10000     0.100E 21     0        0.0
 7    6     10000     10000     0.100E 21     0        0.0
 7    7     10000     10000     0.100E 21     0        0.0
 7    8     10000     10000     0.100E 21     0      303.0
 7    9     10000     10000     0.100E 21     0      179.0
 7   10     10000     10000     0.100E 21     0      466.0
 7   11     10000     10000     0.100E 21     0       92.0
 7   12     10000     10000     0.100E 21     0        0.0
 7   13     10000     10000     0.100E 21     0        0.0
 7   14     10000     10000     0.100E 21     0        0.0
 7   15     10000     10000     0.100E 21     0        0.0
 7   16     10000     10000     0.100E 21     0        0.0
 7   17     10000     10000     0.100E 21     0        0.0
 7   18     10000     10000     0.100E 21     0        0.0
 7   19     10000     10000     0.100E 21     0        0.0
 7   20     10000     10000     0.100E 21     0        0.0
 8    1     10000     10000     0.100E 21     0        0.0
 8    2     10000     10000     0.100E 21     0        0.0
 8    3     10000     10000     0.100E 21     0        0.0
 8    4     10000     10000     0.100E 21     0        0.0
 8    5     10000     10000     0.100E 21     0        0.0
 8    6     10000     10000     0.100E 21     0        0.0
 8    7     10000     10000     0.100E 21     0      327.0
 8    8     10000     10000     0.100E 21     0      580.0
 8    9     10000     10000     0.100E 21     0      280.0
 8   10     10000     10000     0.100E 21     0      206.0
 8   11     10000     10000     0.100E 21     0        0.0
 8   12     10000     10000     0.100E 21     0        0.0
 8   13     10000     10000     0.100E 21     0        0.0
 8   14     10000     10000     0.100E 21     0        0.0
 8   15     10000     10000     0.100E 21     0        0.0
 8   16     10000     10000     0.100E 21     0        0.0
 8   17     10000     10000     0.100E 21     0        0.0
 8   18     10000     10000     0.100E 21     0        0.0
 8   19     10000     10000     0.100E 21     0        0.0
 8   20     10000     10000     0.100E 21     0        0.0
 9    1     10000     10000     0.100E 21     0        0.0
 9    2     10000     10000     0.100E 21     0        0.0
 9    3     10000     10000     0.100E 21     0        0.0
 9    4     10000     10000     0.100E 21     0        0.0
 9    5     10000     10000     0.100E 21     0        0.0
 9    6     10000     10000     0.100E 21     0        0.0
 9    7     10000     10000     0.100E 21     0        0.0
 9    8     10000     10000     0.100E 21     0     1931.0
 9    9     10000     10000     0.100E 21     0        0.0
 9   10     10000     10000     0.100E 21     0      225.0
 9   11     10000     10000     0.100E 21     0        0.0
 9   12     10000     10000     0.100E 21     0        0.0
 9   13     10000     10000     0.100E 21     0        0.0
 9   14     10000     10000     0.100E 21     0        0.0
 9   15     10000     10000     0.100E 21     0        0.0
 9   16     10000     10000     0.100E 21     0        0.0
 9   17     10000     10000     0.100E 21     0        0.0
 9   18     10000     10000     0.100E 21     0        0.0
 9   19     10000     10000     0.100E 21     0        0.0
 9   20     10000     10000     0.100E 21     0        0.0
10    1     10000     10000     0.100E 21     0        0.0
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10     2        10000      10000     0.100E 21     0       0.0
10     3        10000      10000     0.100E 21     0       0.0
10     4        10000      10000     0.100E 21     0       0.0
10     5        10000      10000     0.100E 21     0       0.0
10     6        10000      10000     0.100E 21     0    1196.0
10     7        10000      10000     0.100E 21     0       0.0
10     8        10000      10000     0.100E 21     0     772.0
10     9        10000      10000     0.100E 21     0     365.0
10    10        10000      10000     0.100E 21     0     268.0
10    11        10000      10000     0.100E 21     0     353.0
10    12        10000      10000     0.100E 21     0       0.0
10    13        10000      10000     0.100E 21     0       0.0
10    14        10000      10000     0.100E 21     0       0.0
10    15        10000      10000     0.100E 21     0       0.0
10    16        10000      10000     0.100E 21     0       0.0
10    17        10000      10000     0.100E 21     0       0.0
10    18        10000      10000     0.100E 21     0       0.0
10    19        10000      10000     0.100E 21     0       0.0
10    20        10000      10000     0.100E 21     0       0.0
11     1        10000      10000     0.100E 21     0       0.0
11     2        10000      10000     0.100E 21     0       0.0
11     3        10000      10000     0.100E 21     0       0.0
11     4        10000      10000     0.100E 21     0       0.0
11     5        10000      10000     0.100E 21     0       0.0
11     6        10000      10000     0.100E 21     0     995.0
11     7        10000      10000     0.100E 21     0     164.0
11     8        10000      10000     0.100E 21     0       0.0
11     9        10000      10000     0.100E 21     0     411.0
11    10        10000      10000     0.100E 21     0     295.0
11    11        10000      10000     0.100E 21     0       7.0
11    12        10000      10000     0.100E 21     0       0.0
11    13        10000      10000     0.100E 21     0       0.0
11    14        10000      10000     0.100E 21     0       0.0
11    15        10000      10000     0.100E 21     0       0.0
11    16        10000      10000     0.100E 21     0       0.0
11    17        10000      10000     0.100E 21     0       0.0
11    18        10000      10000     0.100E 21     0       0.0
11    19        10000      10000     0.100E 21     0       0.0
11    20        10000      10000     0.100E 21     0       0.0
12     1        10000      10000     0.100E 21     0       0.0
12     2        10000      10000     0.100E 21     0       0.0
12     3        10000      10000     0.100E 21     0       0.0
12     4        10000      10000     0.100E 21     0       0.0
12     5        10000      10000     0.100E 21     0       0.0
12     6        10000      10000     0.100E 21     0       0.0
12     7        10000      10000     0.100E 21     0     426.0
12     8        10000      10000     0.100E 21     0       0.0
12     9        10000      10000     0.100E 21     0     483.0
12    10        10000      10000     0.100E 21     0     193.0
12    11        10000      10000     0.100E 21     0     328.0
12    12        10000      10000     0.100E 21     0       0.0
12    13        10000      10000     0.100E 21     0       0.0
12    14        10000      10000     0.100E 21     0       0.0
12    15        10000      10000     0.100E 21     0       0.0
12    16        10000      10000     0.100E 21     0       0.0
12    17        10000      10000     0.100E 21     0       0.0
12    18        10000      10000     0.100E 21     0       0.0
12    19        10000      10000     0.100E 21     0       0.0
12    20        10000      10000     0.100E 21     0       0.0
13     1        10000      10000     0.100E 21     0       0.0
13     2        10000      10000     0.100E 21     0       0.0
13     3        10000      10000     0.100E 21     0       0.0
13     4        10000      10000     0.100E 21     0       0.0
13     5        10000      10000     0.100E 21     0       0.0
13     6        10000      10000     0.100E 21     0       0.0
13     7        10000      10000     0.100E 21     0      71.0
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13     8          10000        10000      0.100E 21      0        0.0
13     9          10000        10000      0.100E 21      0       58.0
13    10          10000        10000      0.100E 21      0       39.0
13    11          10000        10000      0.100E 21      0      755.0
13    12          10000        10000      0.100E 21      0        0.0
13    13          10000        10000      0.100E 21      0        0.0
13    14          10000        10000      0.100E 21      0        0.0
13    15          10000        10000      0.100E 21      0        0.0
13    16          10000        10000      0.100E 21      0        0.0
13    17          10000        10000      0.100E 21      0        0.0
13    18          10000        10000      0.100E 21      0        0.0
13    19          10000        10000      0.100E 21      0        0.0
13    20          10000        10000      0.100E 21      0        0.0
14     1          10000        10000      0.100E 21      0        0.0
14     2          10000        10000      0.100E 21      0        0.0
14     3          10000        10000      0.100E 21      0        0.0
14     4          10000        10000      0.100E 21      0        0.0
14     5          10000        10000      0.100E 21      0        0.0
14     6          10000        10000      0.100E 21      0        0.0
14     7          10000        10000      0.100E 21      0        0.0
14     8          10000        10000      0.100E 21      0      105.0
14     9          10000        10000      0.100E 21      0       91.0
14    10          10000        10000      0.100E 21      0      909.0
14    11          10000        10000      0.100E 21      0     2232.0
14    12          10000        10000      0.100E 21      0        0.0
14    13          10000        10000      0.100E 21      0        0.0
14    14          10000        10000      0.100E 21      0        0.0
14    15          10000        10000      0.100E 21      0        0.0
14    16          10000        10000      0.100E 21      0        0.0
14    17          10000        10000      0.100E 21      0        0.0
14    18          10000        10000      0.100E 21      0        0.0
14    19          10000        10000      0.100E 21      0        0.0
14    20          10000        10000      0.100E 21      0        0.0
15     1          10000        10000      0.100E 21      0        0.0
15     2          10000        10000      0.100E 21      0        0.0
15     3          10000        10000      0.100E 21      0        0.0
15     4          10000        10000      0.100E 21      0        0.0
15     5          10000        10000      0.100E 21      0        0.0
15     6          10000        10000      0.100E 21      0        0.0
15     7          10000        10000      0.100E 21      0        0.0
15     8          10000        10000      0.100E 21      0        0.0
15     9          10000        10000      0.100E 21      0       80.0
15    10          10000        10000      0.100E 21      0      194.0
15    11          10000        10000      0.100E 21      0     1197.0
15    12          10000        10000      0.100E 21      0        0.0
15    13          10000        10000      0.100E 21      0        0.0
15    14          10000        10000      0.100E 21      0        0.0
15    15          10000        10000      0.100E 21      0        0.0
15    16          10000        10000      0.100E 21      0        0.0
15    17          10000        10000      0.100E 21      0        0.0
15    18          10000        10000      0.100E 21      0        0.0
15    19          10000        10000      0.100E 21      0        0.0
15    20          10000        10000      0.100E 21      0        0.0
16     1          10000        10000      0.100E 21      0        0.0
16     2          10000        10000      0.100E 21      0        0.0
16     3          10000        10000      0.100E 21      0        0.0
16     4          10000        10000      0.100E 21      0      146.0
16     5          10000        10000      0.100E 21      0        0.0
16     6          10000        10000      0.100E 21      0        0.0
16     7          10000        10000      0.100E 21      0        0.0
16     8          10000        10000      0.100E 21      0        0.0
16     9          10000        10000      0.100E 21      0       67.0
16    10          10000        10000      0.100E 21      0      259.0
16    11          10000        10000      0.100E 21      0     6053.0
16    12          10000        10000      0.100E 21      0        0.0
16    13          10000        10000      0.100E 21      0        0.0
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16   14     10000     10000    0.100E 21     0     0.0
16   15     10000     10000    0.100E 21     0     0.0
16   16     10000     10000    0.100E 21     0     0.0
16   17     10000     10000    0.100E 21     0     0.0
16   18     10000     10000    0.100E 21     0     0.0
16   19     10000     10000    0.100E 21     0     0.0
16   20     10000     10000    0.100E 21     0     0.0
17    1     10000     10000    0.100E 21     0     0.0
17    2     10000     10000    0.100E 21     0     0.0
17    3     10000     10000    0.100E 21     0     0.0
17    4     10000     10000    0.100E 21     0     0.0
17    5     10000     10000    0.100E 21     0     0.0
17    6     10000     10000    0.100E 21     0     0.0
17    7     10000     10000    0.100E 21     0     0.0
17    8     10000     10000    0.100E 21     0     0.0
17    9     10000     10000    0.100E 21     0     0.0
17   10     10000     10000    0.100E 21     0     0.0
17   11     10000     10000    0.100E 21     0     0.0
17   12     10000     10000    0.100E 21     0     0.0
17   13     10000     10000    0.100E 21     0     0.0
17   14     10000     10000    0.100E 21     0     0.0
17   15     10000     10000    0.100E 21     0     0.0
17   16     10000     10000    0.100E 21     0     0.0
17   17     10000     10000    0.100E 21     0     0.0
17   18     10000     10000    0.100E 21     0     0.0
17   19     10000     10000    0.100E 21     0     0.0
17   20     10000     10000    0.100E 21     0     0.0
18    1     10000     10000    0.100E 21     0     0.0
18    2     10000     10000    0.100E 21     0     0.0
18    3     10000     10000    0.100E 21     0     0.0
18    4     10000     10000    0.100E 21     0     0.0
18    5     10000     10000    0.100E 21     0     0.0
18    6     10000     10000    0.100E 21     0     0.0
18    7     10000     10000    0.100E 21     0     0.0
18    8     10000     10000    0.100E 21     0     0.0
18    9     10000     10000    0.100E 21     0     0.0
18   10     10000     10000    0.100E 21     0     0.0
18   11     10000     10000    0.100E 21     0     0.0
18   12     10000     10000    0.100E 21     0     0.0
18   13     10000     10000    0.100E 21     0     0.0
18   14     10000     10000    0.100E 21     0     0.0
18   15     10000     10000    0.100E 21     0     0.0
18   16     10000     10000    0.100E 21     0     0.0
18   17     10000     10000    0.100E 21     0     0.0
18   18     10000     10000    0.100E 21     0     0.0
18   19     10000     10000    0.100E 21     0     0.0
18   20     10000     10000    0.100E 21     0     0.0
19    1     10000     10000    0.100E 21     0     0.0
19    2     10000     10000    0.100E 21     0     0.0
19    3     10000     10000    0.100E 21     0     0.0
19    4     10000     10000    0.100E 21     0     0.0
19    5     10000     10000    0.100E 21     0     0.0
19    6     10000     10000    0.100E 21     0     0.0
19    7     10000     10000    0.100E 21     0     0.0
19    8     10000     10000    0.100E 21     0     0.0
19    9     10000     10000    0.100E 21     0     0.0
19   10     10000     10000    0.100E 21     0     0.0
19   11     10000     10000    0.100E 21     0     0.0
19   12     10000     10000    0.100E 21     0     0.0
19   13     10000     10000    0.100E 21     0     0.0
19   14     10000     10000    0.100E 21     0     0.0
19   15     10000     10000    0.100E 21     0     0.0
19   16     10000     10000    0.100E 21     0     0.0
19   17     10000     10000    0.100E 21     0     0.0
19   18     10000     10000    0.100E 21     0     0.0
19   19     10000     10000    0.100E 21     0     0.0
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19    20          10000       10000     0.100E 21        0         0.0
20     1          10000       10000     0.100E 21        0         0.0
20     2          10000       10000     0.100E 21        0         0.0
20     3          10000       10000     0.100E 21        0         0.0
20     4          10000       10000     0.100E 21        0         0.0
20     5          10000       10000     0.100E 21        0         0.0
20     6          10000       10000     0.100E 21        0         0.0
20     7          10000       10000     0.100E 21        0         0.0
20     8          10000       10000     0.100E 21        0         0.0
20     9          10000       10000     0.100E 21        0         0.0
20    10          10000       10000     0.100E 21        0         0.0
20    11          10000       10000     0.100E 21        0         0.0
20    12          10000       10000     0.100E 21        0         0.0
20    13          10000       10000     0.100E 21        0         0.0
20    14          10000       10000     0.100E 21        0         0.0
20    15          10000       10000     0.100E 21        0         0.0
20    16          10000       10000     0.100E 21        0         0.0
20    17          10000       10000     0.100E 21        0         0.0
20    18          10000       10000     0.100E 21        0         0.0
20    19          10000       10000     0.100E 21        0         0.0
20    20          10000       10000     0.100E 21        0         0.0
  FOR WATER AREAS--0= NONE OR MINIMAL AND 1= MAJOR WATER AREA PRESENT
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                LIST OF INPUT VALUES FOR RADIONUCLIDE-INDEPENDENT VARIABLES
NUMBER OF NUCLIDES CONSIDERED                                                                              5
TIME DELAY--INGESTION OF PASTURE GRASS BY ANIMALS (HR)                                               0.0
TIME DELAY--INGESTION OF STORED FEED BY ANIMALS (HR)                                                 0.2160E 04
TIME DELAY--INGESTION OF LEAFY VEGETABLES BY MAN (HR)                                                0.3360E 03
TIME DELAY--INGESTION OF PRODUCE BY MAN (HR)                                                         0.3360E 03
REMOVAL RATE CONSTANT FOR PHYSICAL LOSS BY WEATHERING (PER HOUR)                                     0.2100E-02
PERIOD OF EXPOSURE DURING GROWING SEASON--PASTURE GRASS (HR)                                         0.7200E 03
PERIOD OF EXPOSURE DURING GROWING SEASON--CROPS OR LEAFY VEGETABLES (HR)                             0.1440E 04
AGRICULTURAL PRODUCTIVITY BY UNIT AREA (GRASS-COW-MILK-MAN PATHWAY (KG/SQ. METER))                   0.2800E 00
AGRICULTURAL PRODUCTIVITY BY UNIT AREA (PRODUCE OR LEAFY VEG INGESTED BY MAN (KG/SQ. METER))         0.7160E 00
FRACTION OF YEAR ANIMALS GRAZE ON PASTURE                                                            0.4000E 00
FRACTION OF DAILY FEED THAT IS PASTURE GRASS WHEN ANIMAL GRAZES ON PASTURE                           0.4300E 00
CONSUMPTION RATE OF CONTAMINATED FEED OR FORAGE BY AN ANIMAL IN KG/DAY (DRY WEIGHT)                  0.1560E 02
TRANSPORT TIME FROM ANIMAL FEED-MILK-MAN (DAY)                                                       0.2000E 01
RATE OF INGESTION OF PRODUCE BY MAN (KG/YR)                                                          0.1760E 03
RATE OF INGESTION OF MILK BY MAN (LITERS/YR)                                                         0.1120E 03
RATE OF INGESTION OF MEAT BY MAN (KG/YR)                                                             0.9400E 02
RATE OF INGESTION OF LEAFY VEGETABLES BY MAN (KG/YR)                                                 0.1800E 02
AVERAGE TIME FROM SLAUGHTER OF MEAT ANIMAL TO CONSUMPTION (DAY)                                      0.2000E 02
FRACTION OF PRODUCE INGESTED GROWN IN GARDEN OF INTEREST                                             0.1000E 01
FRACTION OF LEAFY VEGETABLES GROWN IN GARDEN OF INTEREST                                             0.1000E 01
PERIOD OF LONG-TERM BUILDUP FOR ACTIVITY IN SOIL (YEARS)                                             0.1000E 03
EFFECTIVE SURFACE DENSITY OF SOIL (KG/SQ. M, DRY WEIGHT) (ASSUMES 15 CM PLOW LAYER)                  0.2150E 03
VEGETABLE INGESTION RATIO-IMMEDIATE SURROUNDING AREA/TOTAL WITHIN AREA                               0.5000E 00
MEAT INGESTION RATIO-IMMEDIATE SURROUNDING AREA/TOTAL WITHIN AREA                                    0.5000E 00
MILK INGESTION RATIO-IMMEDIATE SURROUNDING AREA/TOTAL WITHIN AREA                                    0.5000E 00

           MINIMUM FRACTIONS OF FOOD TYPES FROM OUTSIDE AREA LISTED BELOW ARE ACTUAL FIXED VALUES
MINIMUM FRACTION VEGETABLES INGESTED FROM OUTSIDE AREA                                               0.2000E 00
MINIMUM FRACTION MEAT INGESTED FROM OUTSIDE AREA                                                     0.2000E 00
MINIMUM FRACTION MILK INGESTED FROM OUTSIDE AREA                                                     0.2000E 00
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INHALATION RATE OF MAN (CUBIC CENTIMETERS/HR)                                                 0.9167E 06
BUILDUP TIME FOR RADIONUCLIDES DEPOSITED ON GROUND AND WATER (DAYS)                           0.3650E 05
DILUTION FACTOR FOR WATER FOR SWIMMING (CM)                                                   0.1524E 03
FRACTION OF TIME SPENT SWIMMING                                                               0.1000E-01
MUSCLE MASS OF ANIMAL AT SLAUGHTER (KG)                                                       0.2000E 03
FRACTION OF ANIMAL HERD SLAUGHTERED PER DAY                                                   0.3810E-02
MILK PRODUCTION OF COW (LITERS/DAY)                                                           0.1100E 02
FALLOUT INTERCEPTION FRACTION-VEGETABLES                                                      0.2000E 00
FALLOUT INTERCEPTION FRACTION-PASTURE                                                         0.5700E 00
FRACTION OF RADIOACTIVITY RETAINED ON LEAFY VEGETABLES AND PRODUCE AFTER WASHING              0.1000E 01
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                              COMPUTED VALUES FOR THE AREA
TOTAL POPULATION
                                                                              53103.0
TOTAL NUMBER OF MEAT ANIMALS                                                  1760000
TOTAL NUMBER OF MILK CATTLE                                                   1760000
TOTAL AREA OF VEGETABLE FOOD CROPS (SQUARE METERS)                        0.1760E 23
TOTAL MEAT CONSUMPTION (KG PER YEAR)                                      0.4992E 07
TOTAL MEAT PRODUCTION (KG PER YEAR)                                       0.4895E 09
TOTAL MILK CONSUMPTION (LITERS/YEAR)                                      0.5948E 07
TOTAL MILK PRODUCTION (LITERS/YEAR)                                       0.7066E 10
TOTAL VEGETABLE FOOD CONSUMPTION (KG PER YEAR)                            0.1030E 08
TOTAL VEGETABLE FOOD PRODUCED (KG PER YEAR)                               0.1260E 23
```

LIST OF INPUT DATA FOR NUCLIDE RA-226

RADIOACTIVE DECAY CONSTANT (PER DAY)	0.1190E-05
ENVIRONMENTAL DECAY CONSTANT--SURFACE (PER DAY)	0.0
ENVIRONMENTAL DECAY CONSTANT--WATER (PER DAY)	0.0
AVERAGE FRACTION OF ANIMAL'S DAILY INTAKE OF NUCLIDE WHICH APPEARS IN EACH L OF MILK (DAYS/L)	0.5900E-03
FRACTION OF ANIMAL'S DAILY INTAKE OF NUCLIDE WHICH APPEARS IN EACH KG OF FLESH (DAYS/KG)	0.3000E-02
CONCENTRATION FACTOR FOR UPTAKE OF NUCLIDE FROM SOIL FOR PASTURE AND FORAGE (IN PCI/KG DRY WEIGHT PER PCI/KG DRY SOIL)	0.9700E-01
CONCENTRATION FACTOR FOR UPTAKE OF NUCLIDE FROM SOIL BY EDIBLE PARTS OF CROPS (IN PCI/KG WET WEIGHT PER PCI/KG DRY SOIL)	0.6200E-01
GI UPTAKE FRACTION (INHALATION)	0.2000E 00
GI UPTAKE FRACTION (INGESTION)	0.2000E 00
PARTICLE SIZE (MICRONS)	0.1000E 01
SOLUBILITY CLASS	W

DOSE CONVERSION FACTORS

ORGAN	INHALATION (REMS/MICROCURIE)	INGESTION (REMS/MICROCURIE)	SUBMERSION IN AIR (REMS-CUBIC CM/ MICROCURIE-HR)	SURFACE EXPOSURE (REMS-SQUARE CM/ MICROCURIE-HR)	SUBMERSION IN WATER (REMS-CUBIC CM/ MICROCURIE-HR)
TOT.BODY	0.901E 01	0.726E 01	0.436E 01	0.100E-02	0.936E-02
S WALL	0.270E-02	0.437E-02	0.284E 01	0.654E-03	0.610E-02
LLI WALL	0.179E 00	0.333E 00	0.239E 01	0.548E-03	0.512E-02
LUNGS	0.557E 02	0.515E-04	0.385E 01	0.884E-03	0.825E-02
KIDNEYS	0.662E 00	0.590E 00	0.315E 01	0.725E-03	0.676E-02
LIVER	0.662E 00	0.590E 00	0.333E 01	0.764E-03	0.713E-02
OVARIES	0.664E 00	0.592E 00	0.229E 01	0.526E-03	0.491E-02
R MAR	0.192E 01	0.171E 01	0.626E 01	0.144E-02	0.134E-01
ENDOST	0.990E 01	0.882E 01	0.726E 01	0.167E-02	0.156E-01
TESTES	0.664E 00	0.591E 00	0.532E 01	0.122E-02	0.114E-01
THYROID	0.664E 00	0.591E 00	0.435E 01	0.100E-02	0.934E-02

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                              LIST OF INPUT DATA FOR NUCLIDE PB-210

RADIOACTIVE DECAY CONSTANT (PER DAY)                                                           0.8520E-04

ENVIRONMENTAL DECAY CONSTANT--SURFACE (PER DAY)                                                0.0

ENVIRONMENTAL DECAY CONSTANT--WATER (PER DAY)                                                  0.0

AVERAGE FRACTION OF ANIMAL'S DAILY INTAKE OF NUCLIDE WHICH APPEARS IN EACH L OF MILK (DAYS/L)  0.9900E-04

FRACTION OF ANIMAL'S DAILY INTAKE OF NUCLIDE WHICH APPEARS IN EACH KG OF FLESH (DAYS/KG)       0.9100E-03

CONCENTRATION FACTOR FOR UPTAKE OF NUCLIDE FROM SOIL FOR PASTURE AND FORAGE                    0.1100E 00
      (IN PCI/KG DRY WEIGHT PER PCI/KG DRY SOIL)

CONCENTRATION FACTOR FOR UPTAKE OF NUCLIDE FROM SOIL BY EDIBLE PARTS OF CROPS                  0.3900E-02
      (IN PCI/KG WET WEIGHT PER PCI/KG DRY SOIL)

GI UPTAKE FRACTION (INHALATION)                                                                0.8000E-01

GI UPTAKE FRACTION (INGESTION)                                                                 0.8000E-01

PARTICLE SIZE (MICRONS)                                                                        0.1000E 01

SOLUBILITY CLASS                                                                              W

      CONCENTRATIONS ON GROUND AND WATER INCLUDE CONTRIBUTIONS RESULTING FROM
      DECAY OF THE FOLLOWING PARENT NUCLIDES AFTER DEPOSITION--

                    NUCLIDE                   BUILDUP FACTOR

                    RA-226                      0.221E 01

                                  DOSE CONVERSION FACTORS

ORGAN         INHALATION          INGESTION          SUBMERSION IN AIR     SURFACE EXPOSURE      SUBMERSION IN WATER
          (REMS/MICROCURIE) (REMS/MICROCURIE)       (REMS-CUBIC CM/       (REMS-SQUARE CM/        (REMS-CUBIC CM/
                                                    MICROCURIE-HR)        MICROCURIE-HR)          MICROCURIE-HR)

TOT.BODY      0.150E 02          0.733E 01             0.863E 00             0.874E-03              0.200E-02
S WALL        0.118E-02          0.189E-03             0.478E 00             0.484E-03              0.111E-02
LLI WALL      0.469E-01          0.203E-01             0.272E 00             0.275E-03              0.630E-03
LUNGS         0.618E 01          0.574E-04             0.563E 00             0.570E-03              0.131E-02
KIDNEYS       0.754E 01          0.303E 01             0.497E 00             0.504E-03              0.115E-02
LIVER         0.309E 01          0.144E 01             0.449E 00             0.455E-03              0.104E-02
OVARIES       0.120E 00          0.303E-01             0.454E 00             0.460E-03              0.105E-02
R MAR         0.294E 01          0.142E 01             0.136E 01             0.138E-02              0.315E-02
ENDOST        0.195E 02          0.964E 01             0.180E 01             0.183E-02              0.418E-02
TESTES        0.120E 00          0.303E-01             0.768E 00             0.778E-03              0.178E-02
THYROID       0.120E 00          0.303E-01             0.839E 00             0.849E-03              0.194E-02
```

LIST OF INPUT DATA FOR NUCLIDE PO-210

RADIOACTIVE DECAY CONSTANT (PER DAY)	0.5020E-02
ENVIRONMENTAL DECAY CONSTANT--SURFACE (PER DAY)	0.0
ENVIRONMENTAL DECAY CONSTANT--WATER (PER DAY)	0.0
AVERAGE FRACTION OF ANIMAL'S DAILY INTAKE OF NUCLIDE WHICH APPEARS IN EACH L OF MILK (DAYS/L)	0.1200E-03
FRACTION OF ANIMAL'S DAILY INTAKE OF NUCLIDE WHICH APPEARS IN EACH KG OF FLESH (DAYS/KG)	0.4000E-02
CONCENTRATION FACTOR FOR UPTAKE OF NUCLIDE FROM SOIL FOR PASTURE AND FORAGE (IN PCI/KG DRY WEIGHT PER PCI/KG DRY SOIL)	0.4200E-02
CONCENTRATION FACTOR FOR UPTAKE OF NUCLIDE FROM SOIL BY EDIBLE PARTS OF CROPS (IN PCI/KG WET WEIGHT PER PCI/KG DRY SOIL)	0.2600E-03
GI UPTAKE FRACTION (INHALATION)	0.1000E 00
GI UPTAKE FRACTION (INGESTION)	0.1000E 00
PARTICLE SIZE (MICRONS)	0.1000E 01
SOLUBILITY CLASS	W

CONCENTRATIONS ON GROUND AND WATER INCLUDE CONTRIBUTIONS RESULTING FROM DECAY OF THE FOLLOWING PARENT NUCLIDES AFTER DEPOSITION--

NUCLIDE	BUILDUP FACTOR
RA-226	0.124E 03

DOSE CONVERSION FACTORS

ORGAN	INHALATION (REMS/MICROCURIE)	INGESTION (REMS/MICROCURIE)	SUBMERSION IN AIR (REMS-CUBIC CM/ MICROCURIE-HR)	SURFACE EXPOSURE (REMS-SQUARE CM/ MICROCURIE-HR)	SUBMERSION IN WATER (REMS-CUBIC CM/ MICROCURIE-HR)
TOT. BODY	0.156E 01	0.562E 00	0.525E-02	0.102E-05	0.113E-04
S WALL	0.222E-02	0.454E-02	0.470E-02	0.914E-06	0.101E-04
LLI WALL	0.879E-01	0.179E 00	0.351E-02	0.684E-06	0.757E-05
LUNGS	0.458E 02	0.113E-07	0.494E-02	0.962E-06	0.107E-04
KIDNEYS	0.144E 02	0.932E 01	0.485E-02	0.944E-06	0.105E-04
LIVER	0.248E 01	0.161E 01	0.449E-02	0.874E-06	0.968E-05
OVARIES	0.803E 00	0.521E 00	0.272E-02	0.529E-06	0.586E-05
R MAR	0.855E 00	0.554E 00	0.556E-02	0.108E-05	0.120E-04
ENDOST	0.374E 00	0.242E 00	0.634E-02	0.123E-05	0.137E-04
TESTES	0.803E 00	0.521E 00	0.513E-02	0.998E-06	0.111E-04
THYROID	0.803E 00	0.521E 00	0.402E-02	0.783E-06	0.867E-05

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                              LIST OF INPUT DATA FOR NUCLIDE RN-222

RADIOACTIVE DECAY CONSTANT (PER DAY)                                                  0.1810E 00

ENVIRONMENTAL DECAY CONSTANT--SURFACE (PER DAY)                                       0.0

ENVIRONMENTAL DECAY CONSTANT--WATER (PER DAY)                                         0.0

AVERAGE FRACTION OF ANIMAL'S DAILY INTAKE OF NUCLIDE WHICH APPEARS IN EACH L OF MILK (DAYS/L)   0.0

FRACTION OF ANIMAL'S DAILY INTAKE OF NUCLIDE WHICH APPEARS IN EACH KG OF FLESH (DAYS/KG)        0.0

CONCENTRATION FACTOR FOR UPTAKE OF NUCLIDE FROM SOIL FOR PASTURE AND FORAGE           0.0
       (IN PCI/KG DRY WEIGHT PER PCI/KG DRY SOIL)

CONCENTRATION FACTOR FOR UPTAKE OF NUCLIDE FROM SOIL BY EDIBLE PARTS OF CROPS         0.0
       (IN PCI/KG WET WEIGHT PER PCI/KG DRY SOIL)

GI UPTAKE FRACTION (INHALATION)                                                       0.0

GI UPTAKE FRACTION (INGESTION)                                                        0.0

PARTICLE SIZE (MICRONS)                                                               0.1000E 01

SOLUBILITY CLASS                                                                     *

                                       DOSE CONVERSION FACTORS

ORGAN          INHALATION          INGESTION           SUBMERSION IN AIR     SURFACE EXPOSURE      SUBMERSION IN WATER
          (REMS/MICROCURIE) (REMS/MICROCURIE)         (REMS-CUBIC CM/       (REMS-SQUARE CM/        (REMS-CUBIC CM/
                                                     MICROCURIE-HR)        MICROCURIE-HR)          MICROCURIE-HR)

TOT.BODY          0.229E-04        0.459E-02           0.244E 00             0.502E-04              0.521E-03
S WALL            0.488E-06        0.148E-01           0.242E 00             0.497E-04              0.516E-03
LLI WALL          0.141E-07        0.686E 00           0.178E 00             0.366E-04              0.380E-03
LUNGS             0.140E-02        0.115E-03           0.228E 00             0.469E-04              0.487E-03
KIDNEYS           0.503E-04        0.144E-01           0.212E 00             0.437E-04              0.453E-03
LIVER             0.413E-05        0.190E-02           0.211E 00             0.434E-04              0.451E-03
OVARIES           0.825E-06        0.540E-02           0.908E-01             0.187E-04              0.194E-03
R MAR             0.991E-05        0.473E-02           0.283E 00             0.582E-04              0.604E-03
ENDOST            0.334E-04        0.131E-01           0.311E 00             0.639E-04              0.664E-03
TESTES            0.818E-06        0.677E-03           0.274E 00             0.563E-04              0.585E-03
THYROID           0.837E-06        0.214E-03           0.202E 00             0.415E-04              0.431E-03
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                         LIST OF INPUT DATA FOR NUCLIDE H-3

      RADIOACTIVE DECAY CONSTANT (PER DAY)                                             0.1540E-03

      ENVIRONMENTAL DECAY CONSTANT--SURFACE (PER DAY)                                  0.0

      ENVIRONMENTAL DECAY CONSTANT--WATER (PER DAY)                                    0.0

      DOS2 CONVERSION FACTOR FOR FOOD INGESTION (REM-CC/PCI-YEAR)                      0.6180E 01

      DOSE CONVERSION FACTOR FOR WATER INGESTION (REM-CC/PCI-YEAR)                     0.5700E-01

                                             DOSE CONVERSION FACTORS

  ORGAN         INHALATION       INGESTION        SUBMERSION IN AIR     SURFACE EXPOSURE     SUBMERSION IN WATER
             (REMS/MICROCURIE) (REMS/MICROCURIE)   (REMS-CUBIC CM/      (REMS-SQUARE CM/       (REMS-CUBIC CM/
                                                    MICROCURIE-HR)       MICROCURIE-HR)         MICROCURIE-HR)


TOT.BODY        0.125E-03        0.830E-04             0.0                  0.0                   0.0
S WALL          0.125E-03        0.108E-03             0.0                  0.0                   0.0
LLI WALL        0.133E-03        0.143E-03             0.0                  0.0                   0.0
LUNGS           0.125E-03        0.836E-04             0.0                  0.0                   0.0
KIDNEYS         0.129E-03        0.856E-04             0.0                  0.0                   0.0
LIVER           0.124E-03        0.828E-04             0.0                  0.0                   0.0
OVARIES         0.124E-03        0.829E-04             0.0                  0.0                   0.0
R MAR           0.124E-03        0.826E-04             0.0                  0.0                   0.0
ENDOST          0.985E-04        0.656E-04             0.0                  0.0                   0.0
TESTES          0.125E-03        0.830E-04             0.0                  0.0                   0.0
THYROID         0.124E-03        0.828E-04             0.0                  0.0                   0.0
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POPULATION-WEIGHTED CONCENTRATIONS AND POPULATION INTAKES FOR RA-226

AREA DIRECTION	DISTANCE (METERS)	AIR CONCENTRATION (MAN-CURIES/CUBIC METER)	GROUND CONCENTRATION (MAN-CURIES/SQUARE METER)	INGESTION INTAKE (MAN-PCI/YEAR)	INHALATION INTAKE (MAN-PCI/YEAR)
1	1207	0.0	0.0	0.0	0.0
1	2414	0.0	0.0	0.0	0.0
1	4023	0.0	0.0	0.0	0.0
1	5632	0.0	0.0	0.0	0.0
1	7241	0.0	0.0	0.0	0.0
1	12068	0.147E-15	0.523E-08	0.168E 04	0.118E 01
1	20113	0.0	0.0	0.0	0.0
1	32180	0.0	0.0	0.0	0.0
1	48270	0.169E-17	0.586E-10	0.199E 03	0.135E-01
1	64360	0.533E-16	0.231E-08	0.121E 05	0.428E 00
1	80450	0.264E-15	0.118E-07	0.919E 05	0.212E 01
2	1207	0.0	0.0	0.0	0.0
2	2414	0.0	0.0	0.0	0.0
2	4023	0.0	0.0	0.0	0.0
2	5632	0.0	0.0	0.0	0.0
2	7241	0.0	0.0	0.0	0.0
2	12068	0.0	0.0	0.0	0.0
2	20113	0.202E-15	0.713E-08	0.800E 04	0.162E 01
2	32180	0.349E-16	0.130E-08	0.362E 04	0.280E 00
2	48270	0.753E-16	0.291E-08	0.162E 05	0.605E 00
2	64360	0.165E-16	0.687E-09	0.776E 04	0.133E 00
2	80450	0.958E-17	0.412E-09	0.712E 04	0.769E-01
3	1207	0.0	0.0	0.0	0.0
3	2414	0.0	0.0	0.0	0.0
3	4023	0.0	0.0	0.0	0.0
3	5632	0.0	0.0	0.0	0.0
3	7241	0.0	0.0	0.0	0.0
3	12068	0.0	0.0	0.0	0.0
3	20113	0.0	0.0	0.0	0.0
3	32180	0.0	0.0	0.0	0.0
3	48270	0.174E-15	0.649E-08	0.255E 05	0.140E 01
3	64360	0.101E-15	0.403E-08	0.338E 05	0.809E 00
3	80450	0.267E-16	0.110E-08	0.144E 05	0.214E 00
4	1207	0.0	0.0	0.0	0.0
4	2414	0.0	0.0	0.0	0.0
4	4023	0.0	0.0	0.0	0.0
4	5632	0.0	0.0	0.0	0.0
4	7241	0.0	0.0	0.0	0.0
4	12068	0.0	0.0	0.0	0.0
4	20113	0.155E-15	0.531E-08	0.420E 04	0.124E 01
4	32180	0.801E-16	0.286E-08	0.541E 04	0.643E 00
4	48270	0.978E-16	0.358E-08	0.134E 05	0.785E 00
4	64360	0.420E-15	0.161E-07	0.117E 06	0.337E 01
4	80450	0.448E-15	0.176E-07	0.192E 06	0.360E 01
5	1207	0.0	0.0	0.0	0.0
5	2414	0.0	0.0	0.0	0.0
5	4023	0.0	0.0	0.0	0.0
5	5632	0.0	0.0	0.0	0.0
5	7241	0.0	0.0	0.0	0.0
5	12068	0.216E-15	0.732E-08	0.408E 04	0.174E 01
5	20113	0.182E-15	0.635E-08	0.797E 04	0.147E 01
5	32180	0.0	0.0	0.0	0.0
5	48270	0.154E-16	0.571E-09	0.312E 04	0.124E 00
5	64360	0.721E-17	0.277E-09	0.272E 04	0.579E-01
5	80450	0.288E-15	0.113E-07	0.165E 06	0.231E 01

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 6      1207       0.0            0.0            0.0           0.0
 6      2414       0.576E-14      0.184E-06      0.142E 05     0.463E 02
 6      4023       0.0            0.0            0.0           0.0
 6      5632       0.0            0.0            0.0           0.0
 6      7241       0.0            0.0            0.0           0.0
 6     12068       0.0            0.0            0.0           0.0
 6     20113       0.0            0.0            0.0           0.0
 6     32180       0.315E-16      0.118E-08      0.664E 04     0.253E 00
 6     48270       0.166E-16      0.641P-09      0.713E 04     0.133E 00
 6     64360       0.252E-15      0.103E-07      0.219E 06     0.202E 01
 6     80450       0.151E-15      0.632E-08      0.205E 06     0.121E 01
 7      1207       0.0            0.0            0.0           0.0
 7      2414       0.0            0.0            0.0           0.0
 7      4023       0.0            0.0            0.0           0.0
 7      5632       0.0            0.0            0.0           0.0
 7      7241       0.0            0.0            0.0           0.0
 7     12068       0.0            0.0            0.0           0.0
 7     20113       0.0            0.0            0.0           0.0
 7     32180       0.761E-16      0.290E-08      0.120E 05     0.611E 00
 7     48270       0.216E-16      0.854E-09      0.706E 04     0.174E 00
 7     64360       0.262E-16      0.111E-08      0.183E 05     0.211E 00
 7     80450       0.326E-17      0.142E-09      0.362E 04     0.262E-01
 8      1207       0.0            0.0            0.0           0.0
 8      2414       0.0            0.0            0.0           0.0
 8      4023       0.0            0.0            0.0           0.0
 8      5632       0.0            0.0            0.0           0.0
 8      7241       0.0            0.0            0.0           0.0
 8     12068       0.0            0.0            0.0           0.0
 8     20113       0.334E-15      0.117E-07      0.133E 05     0.268E 01
 8     32180       0.234E-15      0.848E-08      0.231E 05     0.188E 01
 8     48270       0.553E-16      0.206E-08      0.111E 05     0.444E 00
 8     64360       0.185E-16      0.731E-09      0.811E 04     0.148E 00
 8     80450       0.0            0.0            0.0           0.0
 9      1207       0.0            0.0            0.0           0.0
 9      2414       0.0            0.0            0.0           0.0
 9      4023       0.0            0.0            0.0           0.0
 9      5632       0.0            0.0            0.0           0.0
 9      7241       0.0            0.0            0.0           0.0
 9     12068       0.0            0.0            0.0           0.0
 9     20113       0.0            0.0            0.0           0.0
 9     32180       0.225E-14      0.817E-07      0.788E 05     0.181E 02
 9     48270       0.0            0.0            0.0           0.0
 9     64360       0.622E-16      0.245E-08      0.892E 04     0.500E 00
 9     80450       0.0            0.0            0.0           0.0
10      1207       0.0            0.0            0.0           0.0
10      2414       0.0            0.0            0.0           0.0
10      4023       0.0            0.0            0.0           0.0
10      5632       0.0            0.0            0.0           0.0
10      7241       0.0            0.0            0.0           0.0
10     12068       0.360E-14      0.126E-06      0.516E 05     0.289E 02
10     20113       0.0            0.0            0.0           0.0
10     32180       0.394E-15      0.150E-07      0.309E 05     0.316E 01
10     48270       0.919E-16      0.362E-08      0.145E 05     0.738E 00
10     64360       0.338E-16      0.142E-08      0.106E 05     0.271E 00
10     80450       0.288E-16      0.124E-08      0.139E 05     0.231E 00
11      1207       0.0            0.0            0.0           0.0
11      2414       0.0            0.0            0.0           0.0
11      4023       0.0            0.0            0.0           0.0
11      5632       0.0            0.0            0.0           0.0
11      7241       0.0            0.0            0.0           0.0
11     12068       0.236E-14      0.852E-07      0.422E 05     0.190E 02
11     20113       0.164E-15      0.617E-08      0.667E 04     0.132E 01
11     32180       0.0            0.0            0.0           0.0
11     48270       0.885E-16      0.366E-08      0.163E 05     0.711E 00
11     64360       0.339E-16      0.148E-08      0.116E 05     0.272E 00
11     80450       0.528E-18      0.238E-10      0.276E 03     0.424E-02
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 12        1207          0.0            0.0            0.0            0.0
 12        2414          0.0            0.0            0.0            0.0
 12        4023          0.0            0.0            0.0            0.0
 12        5632          0.0            0.0            0.0            0.0
 12        7241          0.0            0.0            0.0            0.0
 12       12068          0.0            0.0            0.0            0.0
 12       20113          0.380E-15      0.145E-07      0.173E 05      0.305E 01
 12       32180          0.0            0.0            0.0            0.0
 12       48270          0.956E-16      0.403E-08      0.191E 05      0.768E 00
 12       64360          0.208E-16      0.928E-09      0.761E 04      0.167E 00
 12       80450          0.234E-16      0.107E-08      0.129E 05      0.188E 00
 13        1207          0.0            0.0            0.0            0.0
 13        2414          0.0            0.0            0.0            0.0
 13        4023          0.0            0.0            0.0            0.0
 13        5632          0.0            0.0            0.0            0.0
 13        7241          0.0            0.0            0.0            0.0
 13       12068          0.0            0.0            0.0            0.0
 13       20113          0.552E-16      0.217E-08      0.287E 04      0.444E 00
 13       32180          0.0            0.0            0.0            0.0
 13       48270          0.103E-16      0.445E-09      0.229E 04      0.825E-01
 13       64360          0.382E-17      0.175E-09      0.154E 04      0.306E-01
 13       80450          0.491E-16      0.232E-08      0.297E 05      0.395E 00
 14        1207          0.0            0.0            0.0            0.0
 14        2414          0.0            0.0            0.0            0.0
 14        4023          0.0            0.0            0.0            0.0
 14        5632          0.0            0.0            0.0            0.0
 14        7241          0.0            0.0            0.0            0.0
 14       12068          0.0            0.0            0.0            0.0
 14       20113          0.0            0.0            0.0            0.0
 14       32180          0.410E-16      0.166E-08      0.418E 04      0.329E 00
 14       48270          0.181E-16      0.765E-09      0.360E 04      0.145E 00
 14       64360          0.988E-16      0.444E-08      0.359E 05      0.793E 00
 14       80450          0.161E-15      0.747E-08      0.879E 05      0.129E 01
 15        1207          0.0            0.0            0.0            0.0
 15        2414          0.0            0.0            0.0            0.0
 15        4023          0.0            0.0            0.0            0.0
 15        5632          0.0            0.0            0.0            0.0
 15        7241          0.0            0.0            0.0            0.0
 15       12068          0.0            0.0            0.0            0.0
 15       20113          0.0            0.0            0.0            0.0
 15       32180          0.0            0.0            0.0            0.0
 15       48270          0.191E-16      0.822E-09      0.317E 04      0.154E 00
 15       64360          0.253E-16      0.115E-08      0.766E 04      0.203E 00
 15       80450          0.103E-15      0.486E-08      0.472E 05      0.827E 00
 16        1207          0.0            0.0            0.0            0.0
 16        2414          0.0            0.0            0.0            0.0
 16        4023          0.0            0.0            0.0            0.0
 16        5632          0.127E-14      0.430E-07      0.731E 04      0.102E 02
 16        7241          0.0            0.0            0.0            0.0
 16       12068          0.0            0.0            0.0            0.0
 16       20113          0.0            0.0            0.0            0.0
 16       32180          0.0            0.0            0.0            0.0
 16       48270          0.141E-16      0.583E-09      0.265E 04      0.113E 00
 16       64360          0.294E-16      0.129E-08      0.102E 05      0.236E 00
 16       80450          0.454E-15      0.206E-07      0.238E 06      0.365E 01

    DIRECTIONS ARE NUMBERED COUNTERCLOCKWISE STARTING AT 1 FOR DUE NORTH
```

POPULATION-WEIGHTED CONCENTRATIONS AND POPULATION INTAKES FOR PB-210

AREA DIRECTION	DISTANCE (METERS)	AIR CONCENTRATION (MAN-CURIES/CUBIC METER)	GROUND CONCENTRATION (MAN-CURIES/SQUARE METER)	INGESTION INTAKE (MAN-PCI/YEAR)	INHALATION INTAKE (MAN-PCI/YEAR)
1	1207	0.0	0.0	0.0	0.0
1	2414	0.0	0.0	0.0	0.0
1	4023	0.0	0.0	0.0	0.0
1	5632	0.0	0.0	0.0	0.0
1	7241	0.0	0.0	0.0	0.0
1	12068	0.0	0.363E-08	0.545E 02	0.0
1	20113	0.0	0.0	0.0	0.0
1	32180	0.0	0.0	0.0	0.0
1	48270	0.0	0.476E-10	0.643E 01	0.0
1	64360	0.0	0.161E-08	0.391E 03	0.0
1	80450	0.0	0.821E-08	0.297E 04	0.0
2	1207	0.0	0.0	0.0	0.0
2	2414	0.0	0.0	0.0	0.0
2	4023	0.0	0.0	0.0	0.0
2	5632	0.0	0.0	0.0	0.0
2	7241	0.0	0.0	0.0	0.0
2	12068	0.0	0.0	0.0	0.0
2	20113	0.0	0.495E-08	0.259E 03	0.0
2	32180	0.0	0.902E-09	0.117E 03	0.0
2	48270	0.0	0.202E-08	0.524E 03	0.0
2	64360	0.0	0.477E-09	0.251E 03	0.0
2	80450	0.0	0.286E-09	0.230E 03	0.0
3	1207	0.0	0.0	0.0	0.0
3	2414	0.0	0.0	0.0	0.0
3	4023	0.0	0.0	0.0	0.0
3	5632	0.0	0.0	0.0	0.0
3	7241	0.0	0.0	0.0	0.0
3	12068	0.0	0.0	0.0	0.0
3	20113	0.0	0.0	0.0	0.0
3	32180	0.0	0.0	0.0	0.0
3	48270	0.0	0.450E-08	0.824E 03	0.0
3	64360	0.0	0.279E-08	0.109E 04	0.0
3	80450	0.0	0.761E-09	0.465E 03	0.0
4	1207	0.0	0.0	0.0	0.0
4	2414	0.0	0.0	0.0	0.0
4	4023	0.0	0.0	0.0	0.0
4	5632	0.0	0.0	0.0	0.0
4	7241	0.0	0.0	0.0	0.0
4	12068	0.0	0.0	0.0	0.0
4	20113	0.0	0.369E-08	0.136E 03	0.0
4	32180	0.0	0.198E-08	0.175E 03	0.0
4	48270	0.0	0.249E-08	0.433E 03	0.0
4	64360	0.0	0.112E-07	0.377E 04	0.0
4	80450	0.0	0.122E-07	0.622E 04	0.0
5	1207	0.0	0.0	0.0	0.0
5	2414	0.0	0.0	0.0	0.0
5	4023	0.0	0.0	0.0	0.0
5	5632	0.0	0.0	0.0	0.0
5	7241	0.0	0.0	0.0	0.0
5	12068	0.0	0.508E-08	0.132E 03	0.0
5	20113	0.0	0.440E-08	0.258E 03	0.0
5	32180	0.0	0.0	0.0	0.0
5	48270	0.0	0.396E-09	0.101E 03	0.0
5	64360	0.0	0.192E-09	0.879E 02	0.0
5	80450	0.0	0.786E-08	0.533E 04	0.0

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 6       1207         0.0         0.0          0.0          0.0
 6       2414         0.0         0.127E-06    0.461E 03    0.0
 6       4023         0.0         0.0          0.0          0.0
 6       5632         0.0         0.0          0.0          0.0
 6       7241         0.0         0.0          0.0          0.0
 6      12068         0.0         0.0          0.0          0.0
 6      20113         0.0         0.0          0.0          0.0
 6      32180         0.0         0.820E-09    0.215E 03    0.0
 6      48270         0.0         0.445E-09    0.231E 03    0.0
 6      64360         0.0         0.714E-08    0.710E 04    0.0
 6      80450         0.0         0.438E-08    0.664E 04    0.0
 7       1207         0.0         0.0          0.0          0.0
 7       2414         0.0         0.0          0.0          0.0
 7       4023         0.0         0.0          0.0          0.0
 7       5632         0.0         0.0          0.0          0.0
 7       7241         0.0         0.0          0.0          0.0
 7      12068         0.0         0.0          0.0          0.0
 7      20113         0.0         0.0          0.0          0.0
 7      32180         0.0         0.201E-08    0.388E 03    0.0
 7      48270         0.0         0.593E-09    0.228E 03    0.0
 7      64360         0.0         0.772E-09    0.593E 03    0.0
 7      80450         0.0         0.988E-10    0.117E 03    0.0
 8       1207         0.0         0.0          0.0          0.0
 8       2414         0.0         0.0          0.0          0.0
 8       4023         0.0         0.0          0.0          0.0
 8       5632         0.0         0.0          0.0          0.0
 8       7241         0.0         0.0          0.0          0.0
 8      12068         0.0         0.0          0.0          0.0
 8      20113         0.0         0.808E-08    0.429E 03    0.0
 8      32180         0.0         0.589E-08    0.747E 03    0.0
 8      48270         0.0         0.143E-08    0.358E 03    0.0
 8      64360         0.0         0.507E-09    0.262E 03    0.0
 8      80450         0.0         0.0          0.0          0.0
 9       1207         0.0         0.0          0.0          0.0
 9       2414         0.0         0.0          0.0          0.0
 9       4023         0.0         0.0          0.0          0.0
 9       5632         0.0         0.0          0.0          0.0
 9       7241         0.0         0.0          0.0          0.0
 9      12068         0.0         0.0          0.0          0.0
 9      20113         0.0         0.0          0.0          0.0
 9      32180         0.0         0.567E-07    0.255E 04    0.0
 9      48270         0.0         0.0          0.0          0.0
 9      64360         0.0         0.170E-08    0.289E 03    0.0
 9      80450         0.0         0.0          0.0          0.0
10       1207         0.0         0.0          0.0          0.0
10       2414         0.0         0.0          0.0          0.0
10       4023         0.0         0.0          0.0          0.0
10       5632         0.0         0.0          0.0          0.0
10       7241         0.0         0.0          0.0          0.0
10      12068         0.0         0.872E-07    0.167E 04    0.0
10      20113         0.0         0.0          0.0          0.0
10      32180         0.0         0.104E-07    0.998E 03    0.0
10      48270         0.0         0.251E-08    0.468E 03    0.0
10      64360         0.0         0.983E-09    0.342E 03    0.0
10      80450         0.0         0.862E-09    0.450E 03    0.0
11       1207         0.0         0.0          0.0          0.0
11       2414         0.0         0.0          0.0          0.0
11       4023         0.0         0.0          0.0          0.0
11       5632         0.0         0.0          0.0          0.0
11       7241         0.0         0.0          0.0          0.0
11      12068         0.0         0.591E-07    0.136E 04    0.0
11      20113         0.0         0.428E-08    0.216E 03    0.0
11      32180         0.0         0.0          0.0          0.0
11      48270         0.0         0.254E-08    0.526E 03    0.0
11      64360         0.0         0.103E-08    0.376E 03    0.0
11      80450         0.0         0.165E-10    0.892E 01    0.0
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12      1207        0.0          0.0           0.0             0.0
12      2414        0.0          0.0           0.0             0.0
12      4023        0.0          0.0           0.0             0.0
12      5632        0.0          0.0           0.0             0.0
12      7241        0.0          0.0           0.0             0.0
12     12068        0.0          0.0           0.0             0.0
12     20113        0.0          0.101E-07     0.558E 03       0.0
12     32180        0.0          0.0           0.0             0.0
12     48270        0.0          0.280E-08     0.618E 03       0.0
12     64360        0.0          0.644E-09     0.246E 03       0.0
12     80450        0.0          0.745E-09     0.418E 03       0.0
13      1207        0.0          0.0           0.0             0.0
13      2414        0.0          0.0           0.0             0.0
13      4023        0.0          0.0           0.0             0.0
13      5632        0.0          0.0           0.0             0.0
13      7241        0.0          0.0           0.0             0.0
13     12068        0.0          0.0           0.0             0.0
13     20113        0.0          0.150E-08     0.927E 02       0.0
13     32180        0.0          0.0           0.0             0.0
13     48270        0.0          0.309E-09     0.742E 02       0.0
13     64360        0.0          0.121E-09     0.497E 02       0.0
13     80450        0.0          0.161E-08     0.961E 03       0.0
14      1207        0.0          0.0           0.0             0.0
14      2414        0.0          0.0           0.0             0.0
14      4023        0.0          0.0           0.0             0.0
14      5632        0.0          0.0           0.0             0.0
14      7241        0.0          0.0           0.0             0.0
14     12068        0.0          0.0           0.0             0.0
14     20113        0.0          0.0           0.0             0.0
14     32180        0.0          0.115E-08     0.135E 03       0.0
14     48270        0.0          0.531E-09     0.116E 03       0.0
14     64360        0.0          0.308E-08     0.116E 04       0.0
14     80450        0.0          0.519E-08     0.284E 04       0.0
15      1207        0.0          0.0           0.0             0.0
15      2414        0.0          0.0           0.0             0.0
15      4023        0.0          0.0           0.0             0.0
15      5632        0.0          0.0           0.0             0.0
15      7241        0.0          0.0           0.0             0.0
15     12068        0.0          0.0           0.0             0.0
15     20113        0.0          0.0           0.0             0.0
15     32180        0.0          0.0           0.0             0.0
15     48270        0.0          0.570E-09     0.103E 03       0.0
15     64360        0.0          0.801E-09     0.248E 03       0.0
15     80450        0.0          0.338E-08     0.153E 04       0.0
16      1207        0.0          0.0           0.0             0.0
16      2414        0.0          0.0           0.0             0.0
16      4023        0.0          0.0           0.0             0.0
16      5632        0.0          0.299E-07     0.237E 03       0.0
16      7241        0.0          0.0           0.0             0.0
16     12068        0.0          0.0           0.0             0.0
16     20113        0.0          0.0           0.0             0.0
16     32180        0.0          0.0           0.0             0.0
16     48270        0.0          0.405E-09     0.858E 02       0.0
16     64360        0.0          0.894E-09     0.330E 03       0.0
16     80450        0.0          0.143E-07     0.771E 04       0.0

   DIRECTIONS ARE NUMBERED COUNTERCLOCKWISE STARTING AT 1 FOR DUE NORTH
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POPULATION-WEIGHTED CONCENTRATIONS AND POPULATION INTAKES FOR PO-210

AREA DIRECTION	DISTANCE (METERS)	AIR CONCENTRATION (MAN-CURIES/CUBIC METER)	GROUND CONCENTRATION (MAN-CURIES/SQUARE METER)	INGESTION INTAKE (MAN-PCI/YEAR)	INHALATION INTAKE (MAN-PCI/YEAR)
1	1207	0.0	0.0	0.0	0.0
1	2414	0.0	0.0	0.0	0.0
1	4023	0.0	0.0	0.0	0.0
1	5632	0.0	0.0	0.0	0.0
1	7241	0.0	0.0	0.0	0.0
1	12068	0.294E-15	0.368E-08	0.119E 04	0.236E 01
1	20113	0.0	0.0	0.0	0.0
1	32180	0.0	0.0	0.0	0.0
1	48270	0.337E-17	0.482E-10	0.143E 03	0.271E-01
1	64360	0.107E-15	0.163E-08	0.872E 04	0.857E 00
1	80450	0.527E-15	0.831E-08	0.662E 05	0.424E 01
2	1207	0.0	0.0	0.0	0.0
2	2414	0.0	0.0	0.0	0.0
2	4023	0.0	0.0	0.0	0.0
2	5632	0.0	0.0	0.0	0.0
2	7241	0.0	0.0	0.0	0.0
2	12068	0.0	0.0	0.0	0.0
2	20113	0.404E-15	0.501E-08	0.574E 04	0.324E 01
2	32180	0.698E-16	0.914E-09	0.261E 04	0.561E 00
2	48270	0.151E-15	0.204E-08	0.117E 05	0.121E 01
2	64360	0.331E-16	0.483E-09	0.555E 04	0.266E 00
2	80450	0.192E-16	0.289E-09	0.513E 04	0.154E 00
3	1207	0.0	0.0	0.0	0.0
3	2414	0.0	0.0	0.0	0.0
3	4023	0.0	0.0	0.0	0.0
3	5632	0.0	0.0	0.0	0.0
3	7241	0.0	0.0	0.0	0.0
3	12068	0.0	0.0	0.0	0.0
3	20113	0.0	0.0	0.0	0.0
3	32180	0.0	0.0	0.0	0.0
3	48270	0.348E-15	0.456E-08	0.184E 05	0.279E 01
3	64360	0.201E-15	0.283E-08	0.244E 05	0.162E 01
3	80450	0.533E-16	0.771E-09	0.104E 05	0.428E 00
4	1207	0.0	0.0	0.0	0.0
4	2414	0.0	0.0	0.0	0.0
4	4023	0.0	0.0	0.0	0.0
4	5632	0.0	0.0	0.0	0.0
4	7241	0.0	0.0	0.0	0.0
4	12068	0.0	0.0	0.0	0.0
4	20113	0.309E-15	0.373E-08	0.301E 04	0.249E 01
4	32180	0.160E-15	0.201E-08	0.389E 04	0.129E 01
4	48270	0.196E-15	0.252E-08	0.965E 04	0.157E 01
4	64360	0.839E-15	0.113E-07	0.840E 05	0.674E 01
4	80450	0.896E-15	0.123E-07	0.139E 06	0.719E 01
5	1207	0.0	0.0	0.0	0.0
5	2414	0.0	0.0	0.0	0.0
5	4023	0.0	0.0	0.0	0.0
5	5632	0.0	0.0	0.0	0.0
5	7241	0.0	0.0	0.0	0.0
5	12068	0.432E-15	0.514E-08	0.291E 04	0.347E 01
5	20113	0.365E-15	0.446E-08	0.572E 04	0.293E 01
5	32180	0.0	0.0	0.0	0.0
5	48270	0.308E-16	0.401E-09	0.225E 04	0.247E 00
5	64360	0.144E-16	0.195E-09	0.196E 04	0.116E 00
5	80450	0.576E-15	0.796E-08	0.119E 06	0.463E 01

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 6      1207        0.0           0.0           0.0         0.0
 6      2414        0.115E-13     0.129E-06     0.951E 04   0.925E 02
 6      4023        0.0           0.0           0.0         0.0
 6      5632        0.0           0.0           0.0         0.0
 6      7241        0.0           0.0           0.0         0.0
 6     12066        0.0           0.0           0.0         0.0
 6     20113        0.0           0.0           0.0         0.0
 6     32180        0.630E-16     0.831E-09     0.478E 04   0.506E 00
 6     48270        0.331E-16     0.451E-09     0.514E 04   0.266E 00
 6     64360        0.503E-15     0.723E-08     0.158E 06   0.404E 01
 6     80450        0.301E-15     0.444E-08     0.148E 06   0.242E 01
 7      1207        0.0           0.0           0.0         0.0
 7      2414        0.0           0.0           0.0         0.0
 7      4023        0.0           0.0           0.0         0.0
 7      5632        0.0           0.0           0.0         0.0
 7      7241        0.0           0.0           0.0         0.0
 7     12068        0.0           0.0           0.0         0.0
 7     20113        0.0           0.0           0.0         0.0
 7     32180        0.152E-15     0.204E-08     0.864E 04   0.122E 01
 7     48270        0.432E-16     0.600E-09     0.509E 04   0.347E 00
 7     64360        0.525E-16     0.782E-09     0.132E 05   0.421E 00
 7     80450        0.652E-17     0.100E-09     0.261E 04   0.524E-01
 8      1207        0.0           0.0           0.0         0.0
 8      2414        0.0           0.0           0.0         0.0
 8      4023        0.0           0.0           0.0         0.0
 8      5632        0.0           0.0           0.0         0.0
 8      7241        0.0           0.0           0.0         0.0
 8     12068        0.0           0.0           0.0         0.0
 8     20113        0.668E-15     0.819E-08     0.952E 04   0.536E 01
 8     32180        0.467E-15     0.596E-08     0.166E 05   0.375E 01
 8     48270        0.111E-15     0.145E-08     0.797E 04   0.888E 00
 8     64360        0.369E-16     0.514E-09     0.585E 04   0.297E 00
 8     80450        0.0           0.0           0.0         0.0
 9      1207        0.0           0.0           0.0         0.0
 9      2414        0.0           0.0           0.0         0.0
 9      4023        0.0           0.0           0.0         0.0
 9      5632        0.0           0.0           0.0         0.0
 9      7241        0.0           0.0           0.0         0.0
 9     12068        0.0           0.0           0.0         0.0
 9     20113        0.0           0.0           0.0         0.0
 9     32180        0.450E-14     0.574E-07     0.565E 05   0.361E 02
 9     48270        0.0           0.0           0.0         0.0
 9     64360        0.124E-15     0.172E-08     0.643E 04   0.999E 00
 9     80450        0.0           0.0           0.0         0.0
10      1207        0.0           0.0           0.0         0.0
10      2414        0.0           0.0           0.0         0.0
10      4023        0.0           0.0           0.0         0.0
10      5632        0.0           0.0           0.0         0.0
10      7241        0.0           0.0           0.0         0.0
10     12068        0.721E-14     0.883E-07     0.367E 05   0.579E 02
10     20113        0.0           0.0           0.0         0.0
10     32180        0.787E-15     0.105E-07     0.222E 05   0.632E 01
10     48270        0.184E-15     0.254E-08     0.104E 05   0.148E 01
10     64360        0.676E-16     0.995E-09     0.762E 04   0.543E 00
10     80450        0.575E-16     0.873E-09     0.100E 05   0.462E 00
11      1207        0.0           0.0           0.0         0.0
11      2414        0.0           0.0           0.0         0.0
11      4023        0.0           0.0           0.0         0.0
11      5632        0.0           0.0           0.0         0.0
11      7241        0.0           0.0           0.0         0.0
11     12068        0.473E-14     0.598E-07     0.301E 05   0.380E 02
11     20113        0.328E-15     0.434E-08     0.478E 04   0.263E 01
11     32180        0.0           0.0           0.0         0.0
11     48270        0.177E-15     0.257E-08     0.117E 05   0.142E 01
11     64360        0.678E-16     0.104E-08     0.839E 04   0.544E 00
11     80450        0.106E-17     0.167E-10     0.199E 03   0.848E-02
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12     1207    0.0           0.0           0.0           0.0
12     2414    0.0           0.0           0.0           0.0
12     4023    0.0           0.0           0.0           0.0
12     5632    0.0           0.0           0.0           0.0
12     7241    0.0           0.0           0.0           0.0
12    12068    0.0           0.0           0.0           0.0
12    20113    0.759E-15     0.102E-07     0.124E 05     0.610E 01
12    32180    0.0           0.0           0.0           0.0
12    48270    0.191E-15     0.283E-08     0.138E 05     0.154E 01
12    64360    0.416E-16     0.652E-09     0.549E 04     0.334E 00
12    80450    0.468E-16     0.755E-09     0.931E 04     0.376E 00
13     1207    0.0           0.0           0.0           0.0
13     2414    0.0           0.0           0.0           0.0
13     4023    0.0           0.0           0.0           0.0
13     5632    0.0           0.0           0.0           0.0
13     7241    0.0           0.0           0.0           0.0
13    12068    0.0           0.0           0.0           0.0
13    20113    0.110E-15     0.152E-08     0.206E 04     0.887E 00
13    32180    0.0           0.0           0.0           0.0
13    48270    0.205E-16     0.313E-09     0.165E 04     0.165E 00
13    64360    0.763E-17     0.123E-09     0.111E 04     0.613E-01
13    80450    0.983E-16     0.163E-08     0.214E 05     0.789E 00
14     1207    0.0           0.0           0.0           0.0
14     2414    0.0           0.0           0.0           0.0
14     4023    0.0           0.0           0.0           0.0
14     5632    0.0           0.0           0.0           0.0
14     7241    0.0           0.0           0.0           0.0
14    12068    0.0           0.0           0.0           0.0
14    20113    0.0           0.0           0.0           0.0
14    32180    0.820E-16     0.117E-08     0.301E 04     0.658E 00
14    48270    0.361E-16     0.538E-09     0.259E 04     0.290E 00
14    64360    0.198E-15     0.312E-08     0.258E 05     0.159E 01
14    80450    0.322E-15     0.525E-08     0.634E 05     0.259E 01
15     1207    0.0           0.0           0.0           0.0
15     2414    0.0           0.0           0.0           0.0
15     4023    0.0           0.0           0.0           0.0
15     5632    0.0           0.0           0.0           0.0
15     7241    0.0           0.0           0.0           0.0
15    12068    0.0           0.0           0.0           0.0
15    20113    0.0           0.0           0.0           0.0
15    32180    0.0           0.0           0.0           0.0
15    48270    0.383E-16     0.577E-09     0.228E 04     0.307E 00
15    64360    0.506E-16     0.811E-09     0.552E 04     0.406E 00
15    80450    0.206E-15     0.342E-08     0.340E 05     0.165E 01
16     1207    0.0           0.0           0.0           0.0
16     2414    0.0           0.0           0.0           0.0
16     4023    0.0           0.0           0.0           0.0
16     5632    0.254E-14     0.302E-07     0.509E 04     0.204E 02
16     7241    0.0           0.0           0.0           0.0
16    12068    0.0           0.0           0.0           0.0
16    20113    0.0           0.0           0.0           0.0
16    32180    0.0           0.0           0.0           0.0
16    48270    0.282E-16     0.410E-09     0.191E 04     0.227E 00
16    64360    0.588E-16     0.906E-09     0.736E 04     0.472E 00
16    80450    0.909E-15     0.145E-07     0.172E 06     0.730E 01

DIRECTIONS ARE NUMBERED COUNTERCLOCKWISE STARTING AT 1 FOR DUE NORTH
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POPULATION-WEIGHTED CONCENTRATIONS AND POPULATION INTAKES FOR RN-222

AREA		AIR CONCENTRATION (MAN-CURIES/CUBIC METER)	GROUND CONCENTRATION (MAN-CURIES/SQUARE METER)	INGESTION INTAKE (MAN-PCI/YEAR)	INHALATION INTAKE (MAN-PCI/YEAR)
DIRECTION	DISTANCE (METERS)				
1	1207	0.0	0.0	0.0	0.0
1	2414	0.0	0.0	0.0	0.0
1	4023	0.0	0.0	0.0	0.0
1	5632	0.0	0.0	0.0	0.0
1	7241	0.0	0.0	0.0	0.0
1	12068	0.111E-12	0.0	0.0	0.893E 03
1	20113	0.0	0.0	0.0	0.0
1	32180	0.0	0.0	0.0	0.0
1	48270	0.283E-14	0.0	0.0	0.227E 02
1	64360	0.122E-12	0.0	0.0	0.976E 03
1	80450	0.700E-12	0.0	0.0	0.562E 04
2	1207	0.0	0.0	0.0	0.0
2	2414	0.0	0.0	0.0	0.0
2	4023	0.0	0.0	0.0	0.0
2	5632	0.0	0.0	0.0	0.0
2	7241	0.0	0.0	0.0	0.0
2	12068	0.0	0.0	0.0	0.0
2	20113	0.280E-12	0.0	0.0	0.225E 04
2	32180	0.747E-13	0.0	0.0	0.600E 03
2	48270	0.208E-12	0.0	0.0	0.167E 04
2	64360	0.706E-13	0.0	0.0	0.567E 03
2	80450	0.493E-13	0.0	0.0	0.396E 03
3	1207	0.0	0.0	0.0	0.0
3	2414	0.0	0.0	0.0	0.0
3	4023	0.0	0.0	0.0	0.0
3	5632	0.0	0.0	0.0	0.0
3	7241	0.0	0.0	0.0	0.0
3	12068	0.0	0.0	0.0	0.0
3	20113	0.0	0.0	0.0	0.0
3	32180	0.0	0.0	0.0	0.0
3	48270	0.580E-12	0.0	0.0	0.466E 04
3	64360	0.547E-12	0.0	0.0	0.439E 04
3	80450	0.177E-12	0.0	0.0	0.142E 04
4	1207	0.0	0.0	0.0	0.0
4	2414	0.0	0.0	0.0	0.0
4	4023	0.0	0.0	0.0	0.0
4	5632	0.0	0.0	0.0	0.0
4	7241	0.0	0.0	0.0	0.0
4	12068	0.0	0.0	0.0	0.0
4	20113	0.194E-12	0.0	0.0	0.156E 04
4	32180	0.148E-12	0.0	0.0	0.119E 04
4	48270	0.229E-12	0.0	0.0	0.184E 04
4	64360	0.141E-11	0.0	0.0	0.113E 05
4	80450	0.177E-11	0.0	0.0	0.142E 05
5	1207	0.0	0.0	0.0	0.0
5	2414	0.0	0.0	0.0	0.0
5	4023	0.0	0.0	0.0	0.0
5	5632	0.0	0.0	0.0	0.0
5	7241	0.0	0.0	0.0	0.0
5	12068	0.169E-12	0.0	0.0	0.136E 04
5	20113	0.189E-12	0.0	0.0	0.151E 04
5	32180	0.0	0.0	0.0	0.0
5	48270	0.265E-13	0.0	0.0	0.213E 03
5	64360	0.163E-13	0.0	0.0	0.131E 03
5	80450	0.745E-12	0.0	0.0	0.598E 04

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 6     1207      0.0          0.0      0.0      0.0
 6     2414      0.256E-11    0.0      0.0      0.207E 05
 6     4023      0.0          0.0      0.0      0.0
 6     5632      0.0          0.0      0.0      0.0
 6     7241      0.0          0.0      0.0      0.0
 6    12068      0.0          0.0      0.0      0.0
 6    20113      0.0          0.0      0.0      0.0
 6    32180      0.751E-13    0.0      0.0      0.603E 03
 6    48270      0.498E-13    0.0      0.0      0.400E 03
 6    64360      0.108E-11    0.0      0.0      0.866E 04
 6    80450      0.764E-12    0.0      0.0      0.614E 04
 7     1207      0.0          0.0      0.0      0.0
 7     2414      0.0          0.0      0.0      0.0
 7     4023      0.0          0.0      0.0      0.0
 7     5632      0.0          0.0      0.0      0.0
 7     7241      0.0          0.0      0.0      0.0
 7    12068      0.0          0.0      0.0      0.0
 7    20113      0.0          0.0      0.0      0.0
 7    32180      0.224E-12    0.0      0.0      0.180E 04
 7    48270      0.817E-13    0.0      0.0      0.656E 03
 7    64360      0.150E-12    0.0      0.0      0.120E 04
 7    80450      0.224E-13    0.0      0.0      0.180E 03
 8     1207      0.0          0.0      0.0      0.0
 8     2414      0.0          0.0      0.0      0.0
 8     4023      0.0          0.0      0.0      0.0
 8     5632      0.0          0.0      0.0      0.0
 8     7241      0.0          0.0      0.0      0.0
 8    12068      0.0          0.0      0.0      0.0
 8    20113      0.380E-12    0.0      0.0      0.305E 04
 8    32180      0.390E-12    0.0      0.0      0.313E 04
 8    48270      0.117E-12    0.0      0.0      0.936E 03
 8    64360      0.606E-13    0.0      0.0      0.487E 03
 8    80450      0.0          0.0      0.0      0.0
 9     1207      0.0          0.0      0.0      0.0
 9     2414      0.0          0.0      0.0      0.0
 9     4023      0.0          0.0      0.0      0.0
 9     5632      0.0          0.0      0.0      0.0
 9     7241      0.0          0.0      0.0      0.0
 9    12068      0.0          0.0      0.0      0.0
 9    20113      0.0          0.0      0.0      0.0
 9    32180      0.256E-11    0.0      0.0      0.206E 05
 9    48270      0.0          0.0      0.0      0.0
 9    64360      0.130E-12    0.0      0.0      0.104E 04
 9    80450      0.0          0.0      0.0      0.0
10     1207      0.0          0.0      0.0      0.0
10     2414      0.0          0.0      0.0      0.0
10     4023      0.0          0.0      0.0      0.0
10     5632      0.0          0.0      0.0      0.0
10     7241      0.0          0.0      0.0      0.0
10    12068      0.233E-11    0.0      0.0      0.187E 05
10    20113      0.0          0.0      0.0      0.0
10    32180      0.476E-12    0.0      0.0      0.382E 04
10    48270      0.139E-12    0.0      0.0      0.111E 04
10    64360      0.718E-13    0.0      0.0      0.577E 03
10    80450      0.718E-13    0.0      0.0      0.577E 03
11     1207      0.0          0.0      0.0      0.0
11     2414      0.0          0.0      0.0      0.0
11     4023      0.0          0.0      0.0      0.0
11     5632      0.0          0.0      0.0      0.0
11     7241      0.0          0.0      0.0      0.0
11    12068      0.153E-11    0.0      0.0      0.123E 05
11    20113      0.137E-12    0.0      0.0      0.110E 04
11    32180      0.0          0.0      0.0      0.0
11    48270      0.121E-12    0.0      0.0      0.372E 03
11    64360      0.611E-13    0.0      0.0      0.490E 03
11    80450      0.110E-14    0.0      0.0      0.880E 01
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12     1207      0.0          0.0     0.0     0.0
12     2414      0.0          0.0     0.0     0.0
12     4023      0.0          0.0     0.0     0.0
12     5632      0.0          0.0     0.0     0.0
12     7241      0.0          0.0     0.0     0.0
12    12068      0.0          0.0     0.0     0.0
12    20113      0.323E-12    0.0     0.0     0.259E 04
12    32180      0.0          0.0     0.0     0.0
12    48270      0.128E-12    0.0     0.0     0.103E 04
12    64360      0.360E-13    0.0     0.0     0.289E 03
12    80450      0.462E-13    0.0     0.0     0.371E 03
13     1207      0.0          0.0     0.0     0.0
13     2414      0.0          0.0     0.0     0.0
13     4023      0.0          0.0     0.0     0.0
13     5632      0.0          0.0     0.0     0.0
13     7241      0.0          0.0     0.0     0.0
13    12068      0.0          0.0     0.0     0.0
13    20113      0.423E-13    0.0     0.0     0.340E 03
13    32180      0.0          0.0     0.0     0.0
13    48270      0.121E-13    0.0     0.0     0.971E 02
13    64360      0.571E-14    0.0     0.0     0.458E 02
13    80450      0.834E-13    0.0     0.0     0.670E 03
14     1207      0.0          0.0     0.0     0.0
14     2414      0.0          0.0     0.0     0.0
14     4023      0.0          0.0     0.0     0.0
14     5632      0.0          0.0     0.0     0.0
14     7241      0.0          0.0     0.0     0.0
14    12068      0.0          0.0     0.0     0.0
14    20113      0.0          0.0     0.0     0.0
14    32180      0.371E-13    0.0     0.0     0.298E 03
14    48270      0.197E-13    0.0     0.0     0.158E 03
14    64360      0.138E-12    0.0     0.0     0.111E 04
14    80450      0.256E-12    0.0     0.0     0.206E 04
15     1207      0.0          0.0     0.0     0.0
15     2414      0.0          0.0     0.0     0.0
15     4023      0.0          0.0     0.0     0.0
15     5632      0.0          0.0     0.0     0.0
15     7241      0.0          0.0     0.0     0.0
15    12068      0.0          0.0     0.0     0.0
15    20113      0.0          0.0     0.0     0.0
15    32180      0.0          0.0     0.0     0.0
15    48270      0.213E-13    0.0     0.0     0.171E 03
15    64360      0.362E-13    0.0     0.0     0.291E 03
15    80450      0.169E-12    0.0     0.0     0.135E 04
16     1207      0.0          0.0     0.0     0.0
16     2414      0.0          0.0     0.0     0.0
16     4023      0.0          0.0     0.0     0.0
16     5632      0.464E-12    0.0     0.0     0.373E 04
16     7241      0.0          0.0     0.0     0.0
16    12068      0.0          0.0     0.0     0.0
16    20113      0.0          0.0     0.0     0.0
16    32180      0.0          0.0     0.0     0.0
16    48270      0.141E-13    0.0     0.0     0.113E 03
16    64360      0.381E-13    0.0     0.0     0.306E 03
16    80450      0.673E-12    0.0     0.0     0.541E 04

    DIRECTIONS ARE NUMBERED COUNTERCLOCKWISE STARTING AT 1 FOR DUE NORTH
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POPULATION-WEIGHTED CONCENTRATIONS AND POPULATION INTAKES FOR H-3

AREA DIRECTION	DISTANCE (METERS)	AIR CONCENTRATION (MAN-CURIES/CUBIC METER)	GROUND CONCENTRATION (MAN-CURIES/SQUARE METER)	INGESTION INTAKE (MAN-PCI/YEAR)	INHALATION INTAKE (MAN-PCI/YEAR)
1	1207	0.0	0.0	0.0	0.0
1	2414	0.0	0.0	0.0	0.0
1	4023	0.0	0.0	0.0	0.0
1	5632	0.0	0.0	0.0	0.0
1	7241	0.0	0.0	0.0	0.0
1	12068	0.113E-12	0.0	0.147E 05	0.911E 03
1	20113	0.0	0.0	0.0	0.0
1	32180	0.0	0.0	0.0	0.0
1	48270	0.306E-14	0.0	0.158E 04	0.246E 02
1	64360	0.135E-12	0.0	0.953E 05	0.109E 04
1	80450	0.801E-12	0.0	0.719E 06	0.643E 04
2	1207	0.0	0.0	0.0	0.0
2	2414	0.0	0.0	0.0	0.0
2	4023	0.0	0.0	0.0	0.0
2	5632	0.0	0.0	0.0	0.0
2	7241	0.0	0.0	0.0	0.0
2	12068	0.0	0.0	0.0	0.0
2	20113	0.288E-12	0.0	0.672E 05	0.232E 04
2	32180	0.785E-13	0.0	0.295E 05	0.630E 03
2	48270	0.224E-12	0.0	0.129E 06	0.180E 04
2	64360	0.780E-13	0.0	0.611E 05	0.626E 03
2	80450	0.558E-13	0.0	0.557E 05	0.448E 03
3	1207	0.0	0.0	0.0	0.0
3	2414	0.0	0.0	0.0	0.0
3	4023	0.0	0.0	0.0	0.0
3	5632	0.0	0.0	0.0	0.0
3	7241	0.0	0.0	0.0	0.0
3	12068	0.0	0.0	0.0	0.0
3	20113	0.0	0.0	0.0	0.0
3	32180	0.0	0.0	0.0	0.0
3	48270	0.625E-12	0.0	0.210E 06	0.502E 04
3	64360	0.605E-12	0.0	0.274E 06	0.486E 04
3	80450	0.200E-12	0.0	0.115E 06	0.161E 04
4	1207	0.0	0.0	0.0	0.0
4	2414	0.0	0.0	0.0	0.0
4	4023	0.0	0.0	0.0	0.0
4	5632	0.0	0.0	0.0	0.0
4	7241	0.0	0.0	0.0	0.0
4	12068	0.0	0.0	0.0	0.0
4	20113	0.200E-12	0.0	0.363E 05	0.161E 04
4	32180	0.156E-12	0.0	0.448E 05	0.125E 04
4	48270	0.247E-12	0.0	0.108E 06	0.198E 04
4	64360	0.156E-11	0.0	0.927E 06	0.125E 05
4	80450	0.201E-11	0.0	0.152E 07	0.161E 05
5	1207	0.0	0.0	0.0	0.0
5	2414	0.0	0.0	0.0	0.0
5	4023	0.0	0.0	0.0	0.0
5	5632	0.0	0.0	0.0	0.0
5	7241	0.0	0.0	0.0	0.0
5	12068	0.173E-12	0.0	0.340E 05	0.139E 04
5	20113	0.195E-12	0.0	0.645E 05	0.157E 04
5	32180	0.0	0.0	0.0	0.0
5	48270	0.288E-13	0.0	0.244E 05	0.231E 03
5	64360	0.182E-13	0.0	0.211E 05	0.146E 03
5	80450	0.856E-12	0.0	0.127E 07	0.687E 04

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 6      1207        0.0           0.0       0.0          0.0
 6      2414        0.259E-11     0.0       0.132E 06    0.208E 05
 6      4023        0.0           0.0       0.0          0.0
 6      5632        0.0           0.0       0.0          0.0
 6      7241        0.0           0.0       0.0          0.0
 6     12068        0.0           0.0       0.0          0.0
 6     20113        0.0           0.0       0.0          0.0
 6     32180        0.796E-13     0.0       0.525E 05    0.639E 03
 6     48270        0.543E-13     0.0       0.556E 05    0.436E 03
 6     64360        0.121E-11     0.0       0.170E 07    0.974E 04
 6     80450        0.885E-12     0.0       0.159E 07    0.710E 04
 7      1207        0.0           0.0       0.0          0.0
 7      2414        0.0           0.0       0.0          0.0
 7      4023        0.0           0.0       0.0          0.0
 7      5632        0.0           0.0       0.0          0.0
 7      7241        0.0           0.0       0.0          0.0
 7     12068        0.0           0.0       0.0          0.0
 7     20113        0.0           0.0       0.0          0.0
 7     32180        0.237E-12     0.0       0.974E 05    0.190E 04
 7     48270        0.888E-13     0.0       0.560E 05    0.713E 03
 7     64360        0.168E-12     0.0       0.144E 06    0.135E 04
 7     80450        0.258E-13     0.0       0.282E 05    0.207E 03
 8      1207        0.0           0.0       0.0          0.0
 8      2414        0.0           0.0       0.0          0.0
 8      4023        0.0           0.0       0.0          0.0
 8      5632        0.0           0.0       0.0          0.0
 8      7241        0.0           0.0       0.0          0.0
 8     12068        0.0           0.0       0.0          0.0
 8     20113        0.392E-12     0.0       0.109E 06    0.315E 04
 8     32180        0.409E-12     0.0       0.185E 06    0.329E 04
 8     48270        0.125E-12     0.0       0.873E 05    0.101E 04
 8     64360        0.668E-13     0.0       0.635E 05    0.536E 03
 8     80450        0.0           0.0       0.0          0.0
 9      1207        0.0           0.0       0.0          0.0
 9      2414        0.0           0.0       0.0          0.0
 9      4023        0.0           0.0       0.0          0.0
 9      5632        0.0           0.0       0.0          0.0
 9      7241        0.0           0.0       0.0          0.0
 9     12068        0.0           0.0       0.0          0.0
 9     20113        0.0           0.0       0.0          0.0
 9     32180        0.268E-11     0.0       0.655E 06    0.215E 05
 9     48270        0.0           0.0       0.0          0.0
 9     64360        0.142E-12     0.0       0.713E 05    0.114E 04
 9     80450        0.0           0.0       0.0          0.0
10      1207        0.0           0.0       0.0          0.0
10      2414        0.0           0.0       0.0          0.0
10      4023        0.0           0.0       0.0          0.0
10      5632        0.0           0.0       0.0          0.0
10      7241        0.0           0.0       0.0          0.0
10     12068        0.237E-11     0.0       0.426E 06    0.191E 05
10     20113        0.0           0.0       0.0          0.0
10     32180        0.498E-12     0.0       0.245E 06    0.400E 04
10     48270        0.149E-12     0.0       0.113E 06    0.119E 04
10     64360        0.788E-13     0.0       0.823E 05    0.633E 03
10     80450        0.806E-13     0.0       0.108E 06    0.647E 03
11      1207        0.0           0.0       0.0          0.0
11      2414        0.0           0.0       0.0          0.0
11      4023        0.0           0.0       0.0          0.0
11      5632        0.0           0.0       0.0          0.0
11      7241        0.0           0.0       0.0          0.0
11     12068        0.155E-11     0.0       0.342E 06    0.125E 05
11     20113        0.142E-12     0.0       0.531E 05    0.114E 04
11     32180        0.0           0.0       0.0          0.0
11     48270        0.131E-12     0.0       0.127E 06    0.105E 04
11     64360        0.676E-13     0.0       0.901E 05    0.543E 03
11     80450        0.125E-14     0.0       0.213E 04    0.100E 02
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12      1207          0.0          0.0          0.0          0.0
12      2414          0.0          0.0          0.0          0.0
12      4023          0.0          0.0          0.0          0.0
12      5632          0.0          0.0          0.0          0.0
12      7241          0.0          0.0          0.0          0.0
12     12068          0.0          0.0          0.0          0.0
12     20113          0.333E-12    0.0          0.137E 06    0.268E 04
12     32180          0.0          0.0          0.0          0.0
12     48270          0.139E-12    0.0          0.148E 06    0.112E 04
12     64360          0.401E-13    0.0          0.588E 05    0.322E 03
12     80450          0.529E-13    0.0          0.995E 05    0.425E 03
13      1207          0.0          0.0          0.0          0.0
13      2414          0.0          0.0          0.0          0.0
13      4023          0.0          0.0          0.0          0.0
13      5632          0.0          0.0          0.0          0.0
13      7241          0.0          0.0          0.0          0.0
13     12068          0.0          0.0          0.0          0.0
13     20113          0.437E-13    0.0          0.225E 05    0.351E 03
13     32180          0.0          0.0          0.0          0.0
13     48270          0.131E-13    0.0          0.177E 05    0.105E 03
13     64360          0.636E-14    0.0          0.118E 05    0.511E 02
13     80450          0.956E-13    0.0          0.228E 06    0.767E 03
14      1207          0.0          0.0          0.0          0.0
14      2414          0.0          0.0          0.0          0.0
14      4023          0.0          0.0          0.0          0.0
14      5632          0.0          0.0          0.0          0.0
14      7241          0.0          0.0          0.0          0.0
14     12068          0.0          0.0          0.0          0.0
14     20113          0.0          0.0          0.0          0.0
14     32180          0.391E-13    0.0          0.325E 05    0.314E 03
14     48270          0.213E-13    0.0          0.278E 05    0.171E 03
14     64360          0.153E-12    0.0          0.276E 06    0.123E 04
14     80450          0.292E-12    0.0          0.675E 06    0.234E 04
15      1207          0.0          0.0          0.0          0.0
15      2414          0.0          0.0          0.0          0.0
15      4023          0.0          0.0          0.0          0.0
15      5632          0.0          0.0          0.0          0.0
15      7241          0.0          0.0          0.0          0.0
15     12068          0.0          0.0          0.0          0.0
15     20113          0.0          0.0          0.0          0.0
15     32180          0.0          0.0          0.0          0.0
15     48270          0.231E-13    0.0          0.246E 05    0.186E 03
15     64360          0.404E-13    0.0          0.591E 05    0.324E 03
15     80450          0.193E-12    0.0          0.363E 06    0.155E 04
16      1207          0.0          0.0          0.0          0.0
16      2414          0.0          0.0          0.0          0.0
16      4023          0.0          0.0          0.0          0.0
16      5632          0.468E-12    0.0          0.572E 05    0.376E 04
16      7241          0.0          0.0          0.0          0.0
16     12068          0.0          0.0          0.0          0.0
16     20113          0.0          0.0          0.0          0.0
16     32180          0.0          0.0          0.0          0.0
16     48270          0.151E-13    0.0          0.204E 05    0.122E 03
16     64360          0.421E-13    0.0          0.786E 05    0.338E 03
16     80450          0.763E-12    0.0          0.183E 07    0.613E 04

   DIRECTIONS ARE NUMBERED COUNTERCLOCKWISE STARTING AT 1 FOR DUE NORTH
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               PERCENT OF TOT.BODY DOSE BY EACH PATHWAY

NUCLIDE        PATHWAY        DOSE(MAN-REMS)       PERCENT OF TOTAL    PERCENT OF DOSE FROM ALL NUCLIDES

RA-226         SUBM AIR        0.8401E-09                0.00                   99.76
               SURFACE         0.6896E-03                0.00                   62.31
               SWIMMING        0.4223E-06                0.00                   87.03
               INHAL.          0.1590E-02                0.01                   73.40
               INGEST.         0.1535E 02               99.99                   91.87
                 VEGET.        0.1414E 02             * 92.11                 * 84.63
                 MEAT          0.9797E 00             *  6.38                 *  5.87
                 MILK          0.2296E 00             *  1.50                 *  1.37
PB-210         SUBM AIR        0.0                       0.0                     0.0
               SURFACE         0.4167E-03                0.08                   37.65
               SWIMMING        0.6256E-07                0.00                   12.89
               INHAL.          0.0                       0.0                     0.0
               INGEST.         0.5011E 00               99.92                    3.00
                 VEGET.        0.4115E 00             * 82.05                 *  2.46
                 MEAT          0.7929E-01             * 15.81                 *  0.47
                 MILK          0.1029E-01             *  2.05                 *  0.06
PO-210         SUBM AIR        0.2022E-11                0.00                    0.24
               SURFACE         0.4935E-06                0.00                    0.04
               SWIMMING        0.3587E-09                0.00                    0.07
               INHAL.          0.5506E-03                0.06                   25.42
               INGEST.         0.8549E 00               99.94                    5.12
                 VEGET.        0.7366E 00             * 86.11                 *  4.41
                 MEAT          0.1138E 00             * 13.30                 *  0.68
                 MILK          0.4453E-02             *  0.52                 *  0.03
RN-222         SUBM AIR        0.0                       0.0                     0.0
               SURFACE         0.0                       0.0                     0.0
               SWIMMING        0.0                       0.0                     0.0
               INHAL.          0.0                       0.0                     0.0
               INGEST.         0.0                       0.0                     0.0
                 VEGET.        0.0                    *  0.0                  *  0.0
                 MEAT          0.0                    *  0.0                  *  0.0
                 MILK          0.0                    *  0.0                  *  0.0
H-3            SUBM AIR        0.0                       0.0                     0.0
               SURFACE         0.0                       0.0                     0.0
               SWIMMING        0.0                       0.0                     0.0
               INHAL.          0.2575E-04                1.75                    1.19
               INGEST.         0.1442E-02               98.25                    0.01
                 VEGET.        0.7273E-03             * 49.56                 *  0.00
                 MEAT          0.2664E-03             * 18.16                 *  0.00
                 MILK          0.4464E-03             * 30.42                 *  0.00
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              PERCENT OF E MAN    DOSE BY EACH PATHWAY

NUCLIDE       PATHWAY        DOSE(MAN-REMS)      PERCENT OF TOTAL     PERCENT OF DOSE FROM ALL NUCLIDES

RA-226        SUBM AIR        0.1206E-08              0.00                       99.82
              SURFACE         0.9898E-03              0.03                       60.12
              SWIMMING        0.6062E-06              0.00                       85.97
              INHAL.          0.3388E-03              0.01                       50.86
              INGEST.         0.3615E 01             99.96                       79.34
                VEGET.        0.3330E 01           * 92.09                     * 73.09
                 MEAT         0.2308E 00           *  6.38                     *  5.07
                 MILK         0.5408E-01           *  1.50                     *  1.19
PB-210        SUBM AIR        0.0                     0.0                         0.0
              SURFACE         0.6561E-03              0.67                       39.85
              SWIMMING        0.9851E-07              0.00                       13.97
              INHAL.          0.0                     0.0                         0.0
              INGEST.         0.9707E-01             99.33                        2.13
                VEGET.        0.7972E-01           * 81.57                     *  1.75
                 MEAT         0.1536E-01           * 15.72                     *  0.34
                 MILK         0.1994E-02           *  2.04                     *  0.04
PO-210        SUBM AIR        0.2140E-11              0.00                        0.18
              SURFACE         0.5224E-06              0.00                        0.03
              SWIMMING        0.3797E-09              0.00                        0.05
              INHAL.          0.3018E-03              0.04                       45.30
              INGEST.         0.8427E 00             99.96                       18.50
                VEGET.        0.7261E 00           * 86.13                     * 15.94
                 MEAT         0.1122E 00           * 13.31                     *  2.46
                 MILK         0.4390E-02           *  0.52                     *  0.10
RN-222        SUBM AIR        0.0                     0.0                         0.0
              SURFACE         0.0                     0.0                         0.0
              SWIMMING        0.0                     0.0                         0.0
              INHAL.          0.0                     0.0                         0.0
              INGEST.         0.0                     0.0                         0.0
                VEGET.        0.0                  *  0.0                      *  0.0
                 MEAT         0.0                  *  0.0                      *  0.0
                 MILK         0.0                  *  0.0                      *  0.0
H-3           SUBM AIR        0.0                     0.0                         0.0
              SURFACE         0.0                     0.0                         0.0
              SWIMMING        0.0                     0.0                         0.0
              INHAL.          0.2554E-04              1.74                        3.83
              INGEST.         0.1442E-02             98.26                        0.03
                VEGET.        0.7273E-03           * 49.57                     *  0.02
                 MEAT         0.2664E-03           * 18.16                     *  0.01
                 MILK         0.4464E-03           * 30.43                     *  0.01
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PERCENT OF LUNGS   DOSE BY EACH PATHWAY

NUCLIDE	PATHWAY	DOSE(MAN-REMS)	PERCENT OF TOTAL	PERCENT OF DOSE FROM ALL NUCLIDES
RA-226	SUBM AIR	0.7406E-09	0.00	99.74
	SURFACE	0.6079E-03	5.76	69.05
	SWIMMING	0.3723E-06	0.00	90.04
	INHAL.	0.9830E-02	93.20	37.78
	INGEST.	0.1089E-03	1.03	7.00
	VEGET.	0.1003E-03	* 0.95	* 6.45
	MEAT	0.6950E-05	* 0.07	* 0.45
	MILK	0.1629E-05	* 0.02	* 0.10
PB-210	SUBM AIR	0.0	0.0	0.0
	SURFACE	0.2721E-03	98.56	30.90
	SWIMMING	0.4085E-07	0.01	9.88
	INHAL.	0.0	0.0	0.0
	INGEST.	0.3924E-05	1.42	0.25
	VEGET.	0.3223E-05	* 1.17	* 0.21
	MEAT	0.6209E-06	* 0.22	* 0.04
	MILK	0.8061E-07	* 0.03	* 0.01
PO-210	SUBM AIR	0.1903E-11	0.00	0.26
	SURFACE	0.4647E-06	0.00	0.05
	SWIMMING	0.3377E-09	0.00	0.08
	INHAL.	0.1617E-01	100.00	62.12
	INGEST.	0.1719E-07	0.00	0.00
	VEGET.	0.1481E-07	* 0.00	* 0.00
	MEAT	0.2288E-08	* 0.00	* 0.00
	MILK	0.8953E-10	* 0.00	* 0.00
RN-222	SUBM AIR	0.0	0.0	0.0
	SURFACE	0.0	0.0	0.0
	SWIMMING	0.0	0.0	0.0
	INHAL.	0.0	0.0	0.0
	INGEST.	0.0	0.0	0.0
	VEGET.	0.0	* 0.0	* 0.0
	MEAT	0.0	* 0.0	* 0.0
	MILK	0.0	* 0.0	* 0.0
H-3	SUBM AIR	0.0	0.0	0.0
	SURFACE	0.0	0.0	0.0
	SWIMMING	0.0	0.0	0.0
	INHAL.	0.2575E-04	1.75	0.10
	INGEST.	0.1442E-02	98.25	92.74
	VEGET.	0.7273E-03	* 49.56	* 46.79
	MEAT	0.2664E-03	* 18.16	* 17.14
	MILK	0.4464E-03	* 30.42	* 28.72

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                    PERCENT OF ENDOST   DOSE BY EACH PATHWAY
NUCLIDE         PATHWAY         DOSE(MAN-REMS)      PERCENT OF TOTAL    PERCENT OF DOSE FROM ALL NUCLIDES

RA-226          SUBM AIR        0.1397E-08               0.00                   99.83
                SURFACE         0.1147E-02               0.01                   56.82
                SWIMMING        0.7022E-06               0.00                   84.26
                INHAL.          0.1747E-02               0.01                   91.98
                INGEST.         0.1864E 02              99.98                   94.77
                  VEGET.        0.1717E 02            * 92.11                 * 87.30
                   MEAT         0.1190E 01            *  6.38                 *  6.05
                   MILK         0.2789E 00            *  1.50                 *  1.42
PB-210          SUBM AIR        0.0                      0.0                     0.0
                SURFACE         0.8706E-03               0.13                   43.15
                SWIMMING        0.1307E-06               0.00                   15.69
                INHAL.          0.0                      0.0                     0.0
                INGEST.         0.6590E 00              99.87                    3.35
                  VEGET.        0.5412E 00            * 82.01                 *  2.75
                   MEAT         0.1043E 00            * 15.80                 *  0.53
                   MILK         0.1354E-01            *  2.05                 *  0.07
PO-210          SUBM AIR        0.2441E-11               0.00                    0.17
                SURFACE         0.5959E-06               0.00                    0.03
                SWIMMING        0.4331E-09               0.00                    0.05
                INHAL.          0.1320E-03               0.04                    6.95
                INGEST.         0.3681E 00              99.96                    1.87
                  VEGET.        0.3172E 00            * 86.13                 *  1.61
                   MEAT         0.4901E-01            * 13.31                 *  0.25
                   MILK         0.1917E-02            *  0.52                 *  0.01
RN-222          SUBM AIR        0.0                      0.0                     0.0
                SURFACE         0.0                      0.0                     0.0
                SWIMMING        0.0                      0.0                     0.0
                INHAL.          0.0                      0.0                     0.0
                INGEST.         0.0                      0.0                     0.0
                  VEGET.        0.0                   *  0.0                  *  0.0
                   MEAT         0.0                   *  0.0                  *  0.0
                   MILK         0.0                   *  0.0                  *  0.0
H-3             SUBM AIR        0.0                      0.0                     0.0
                SURFACE         0.0                      0.0                     0.0
                SWIMMING        0.0                      0.0                     0.0
                INHAL.          0.2029E-04               1.39                    1.07
                INGEST.         0.1442E-02              98.61                    0.01
                  VEGET.        0.7273E-03            * 49.75                 *  0.00
                   MEAT         0.2664E-03            * 18.22                 *  0.00
                   MILK         0.4464E-03            * 30.54                 *  0.00
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                 PERCENT OF S WALL   DOSE BY EACH PATHWAY

NUCLIDE          PATHWAY          DOSE(MAN-REMS)        PERCENT OF TOTAL    PERCENT OF DOSE FROM ALL NUCLIDES

RA-226           SUBM AIR         0.5477E-09                0.00               99.67
                 SURFACE          0.4495E-03                4.64               66.03
                 SWIMMING         0.2753E-06                0.00               88.72
                 INHAL.           0.4765E-06                0.00                1.76
                 INGEST.          0.9237E-02               95.35               52.49
                   VEGET.         0.8509E-02             * 87.84             * 48.35
                    MEAT          0.5897E-03             *  6.09             *  3.35
                    MILK          0.1382E-03             *  1.43             *  0.79
PB-210           SUBM AIR         0.0                        0.0                0.0
                 SURFACE          0.2309E-03               94.69               33.91
                 SWIMMING         0.3467E-07                0.01               11.17
                 INHAL.           0.0                        0.0                0.0
                 INGEST.          0.1292E-04                5.30                0.07
                   VEGET.         0.1061E-04             *  4.35             *  0.06
                    MEAT          0.2044E-05             *  0.84             *  0.01
                    MILK          0.2654E-06             *  0.11             *  0.00
PO-210           SUBM AIR         0.1808E-11                0.00                0.33
                 SURFACE          0.4414E-06                0.01                0.06
                 SWIMMING         0.3208E-09                0.00                0.10
                 INHAL.           0.7836E-06                0.01                2.90
                 INGEST.          0.6906E-02               99.98               39.24
                   VEGET.         0.5950E-02             * 86.15             * 33.81
                    MEAT          0.9194E-03             * 13.31             *  5.22
                    MILK          0.3597E-04             *  0.52             *  0.20
RN-222           SUBM AIR         0.0                        0.0                0.0
                 SURFACE          0.0                        0.0                0.0
                 SWIMMING         0.0                        0.0                0.0
                 INHAL.           0.0                        0.0                0.0
                 INGEST.          0.0                        0.0                0.0
                   VEGET.         0.0                    *   0.0             *  0.0
                    MEAT          0.0                    *   0.0             *  0.0
                    MILK          0.0                    *   0.0             *  0.0
H-3              SUBM AIR         0.0                        0.0                0.0
                 SURFACE          0.0                        0.0                0.0
                 SWIMMING         0.0                        0.0                0.0
                 INHAL.           0.2575E-04                1.75               95.33
                 INGEST.          0.1442E-02               98.25                8.19
                   VEGET.         0.7273E-03             * 49.56             *  4.13
                    MEAT          0.2664E-03             * 18.16             *  1.51
                    MILK          0.4464E-03             * 30.42             *  2.54
                 PERCENT OF LLI WALL DOSE BY EACH PATHWAY

NUCLIDE          PATHWAY       DOSE(MAN-REMS)      PERCENT OF TOTAL    PERCENT OF DOSE FROM ALL NUCLIDES


RA-226           SUBM AIR        0.4593E-09              0.00                           99.71
                 SURFACE         0.3770E-03              0.05                           74.11
                 SWIMMING        0.2309E-06              0.00                           92.04
                 INHAL.          0.3159E-04              0.00                           35.10
                 INGEST.         0.7039E 00             99.94                           71.90
                   VEGET.        0.6484E 00           * 92.07                         * 66.23
                   MEAT          0.4494E-01           *  6.38                         *  4.59
                   MILK          0.1053E-01           *  1.50                         *  1.08
PB-210           SUBM AIR        0.0                     0.0                             0.0
                 SURFACE         0.1314E-03              8.65                           25.83
                 SWIMMING        0.1973E-07              0.00                            7.86
                 INHAL.          0.0                     0.0                             0.0
                 INGEST.         0.1388E-02             91.35                            0.14
                   VEGET.        0.1140E-02           * 75.02                         *  0.12
                   MEAT          0.2196E-03           * 14.45                         *  0.02
                   MILK          0.2851E-04           *  1.88                         *  0.00
PO-210           SUBM AIR        0.1353E-11              0.00                            0.29
                 SURFACE         0.3303E-06              0.00                            0.06
                 SWIMMING        0.2401E-09              0.00                            0.10
                 INHAL.          0.3102E-04              0.01                           34.47
                 INGEST.         0.2723E 00             99.99                           27.81
                   VEGET.        0.2346E 00           * 86.16                         * 23.96
                   MEAT          0.3625E-01           * 13.31                         *  3.70
                   MILK          0.1418E-02           *  0.52                         *  0.14
RN-222           SUBM AIR        0.0                     0.0                             0.0
                 SURFACE         0.0                     0.0                             0.0
                 SWIMMING        0.0                     0.0                             0.0
                 INHAL.          0.0                     0.0                             0.0
                 INGEST.         0.0                     0.0                             0.0
                   VEGET.        0.0                  *  0.0                          *  0.0
                   MEAT          0.0                  *  0.0                          *  0.0
                   MILK          0.0                  *  0.0                          *  0.0
H-3              SUBM AIR        0.0                     0.0                             0.0
                 SURFACE         0.0                     0.0                             0.0
                 SWIMMING        0.0                     0.0                             0.0
                 INHAL.          0.2739E-04              1.86                           30.44
                 INGEST.         0.1442E-02             98.14                            0.15
                   VEGET.        0.7273E-03           * 49.51                         *  0.07
                   MEAT          0.2664E-03           * 18.14                         *  0.03
                   MILK          0.4464E-03           * 30.39                         *  0.05
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                PERCENT OF THYROID  DOSE BY EACH PATHWAY

NUCLIDE         PATHWAY        DOSE(MAN-REMS)       PERCENT OF TOTAL    PERCENT OF DOSE FROM ALL NUCLIDES

RA-226          SUBM AIR         0.8381E-09               0.00                     99.82
                SURFACE          0.6879E-03               0.06                     62.92
                SWIMMING         0.4213E-06               0.00                     87.34
                INHAL.           0.1172E-03               0.01                     27.50
                INGEST.          0.1249E 01              99.94                     61.08
                  VEGET.         0.1151E 01            * 92.06                   * 56.27
                  MEAT           0.7976E-01            *  6.38                   *  3.90
                  MILK           0.1869E-01            *  1.50                   *  0.91
PB-210          SUBM AIR         0.0                      0.0                       0.0
                SURFACE          0.4050E-03              16.35                     37.04
                SWIMMING         0.6081E-07               0.00                     12.61
                INHAL.           0.0                      0.0                       0.0
                INGEST.          0.2071E-02              83.64                      0.10
                  VEGET.         0.1701E-02            * 68.69                   *  0.08
                  MEAT           0.3278E-03            * 13.24                   *  0.02
                  MILK           0.4255E-04            *  1.72                   *  0.00
PO-210          SUBM AIR         0.1548E-11               0.00                      0.18
                SURFACE          0.3780E-06               0.00                      0.03
                SWIMMING         0.2747E-09               0.00                      0.06
                INHAL.           0.2834E-03               0.04                     66.51
                INGEST.          0.7925E 00              99.96                     38.75
                  VEGET.         0.6829E 00            * 86.13                   * 33.39
                  MEAT           0.1055E 00            * 13.31                   *  5.16
                  MILK           0.4128E-02            *  0.52                   *  0.20
RN-222          SUBM AIR         0.0                      0.0                       0.0
                SURFACE          0.0                      0.0                       0.0
                SWIMMING         0.0                      0.0                       0.0
                INHAL.           0.0                      0.0                       0.0
                INGEST.          0.0                      0.0                       0.0
                  VEGET.         0.0                   *  0.0                    *  0.0
                  MEAT           0.0                   *  0.0                    *  0.0
                  MILK           0.0                   *  0.0                    *  0.0
H-3             SUBM AIR         0.0                      0.0                       0.0
                SURFACE          0.0                      0.0                       0.0
                SWIMMING         0.0                      0.0                       0.0
                INHAL.           0.2554E-04               1.74                      5.99
                INGEST.          0.1442E-02              98.26                      0.07
                  VEGET.         0.7273E-03            * 49.57                   *  0.04
                  MEAT           0.2664E-03            * 18.16                   *  0.01
                  MILK           0.4464E-03            * 30.43                   *  0.02
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                   PERCENT OF LIVER    DOSE BY EACH PATHWAY

NUCLIDE         PATHWAY         DOSE(MAN-REMS)        PERCENT OF TOTAL    PERCENT OF DOSE FROM ALL NUCLIDES

RA-226          SUBM AIR          0.6401E-09               0.00                         99.73
                SURFACE           0.5254E-03               0.04                         70.74
                SWIMMING          0.3218E-06               0.00                         90.73
                INHAL.            0.1168E-03               0.01                         11.48
                INGEST.           0.1247E 01              99.95                         32.85
                  VEGET.          0.1149E 01            * 92.07                       * 30.26
                  MEAT            0.7962E-01            *  6.38                       *  2.10
                  MILK            0.1866E-01            *  1.50                       *  0.49
PB-210          SUBM AIR          0.0                      0.0                           0.0
                SURFACE           0.2169E-03               0.22                         29.20
                SWIMMING          0.3257E-07               0.00                          9.18
                INHAL.            0.0                      0.0                           0.0
                INGEST.           0.9844E-01              99.78                          2.59
                  VEGET.          0.8084E-01            * 81.94                       *  2.13
                  MEAT            0.1558E-01            * 15.79                       *  0.41
                  MILK            0.2022E-02            *  2.05                       *  0.05
PO-210          SUBM AIR          0.1728E-11               0.00                          0.27
                SURFACE           0.4220E-06               0.00                          0.06
                SWIMMING          0.3067E-09               0.00                          0.09
                INHAL.            0.8753E-03               0.04                         86.01
                INGEST.           0.2449E 01              99.96                         64.52
                  VEGET.          0.2110E 01            * 86.13                       * 55.59
                  MEAT            0.3261E 00            * 13.31                       *  8.59
                  MILK            0.1276E-01            *  0.52                       *  0.34
RN-222          SUBM AIR          0.0                      0.0                           0.0
                SURFACE           0.0                      0.0                           0.0
                SWIMMING          0.0                      0.0                           0.0
                INHAL.            0.0                      0.0                           0.0
                INGEST.           0.0                      0.0                           0.0
                  VEGET.          0.0                   *  0.0                        *  0.0
                  MEAT            0.0                   *  0.0                        *  0.0
                  MILK            0.0                   *  0.0                        *  0.0
H-3             SUBM AIR          0.0                      0.0                           0.0
                SURFACE           0.0                      0.0                           0.0
                SWIMMING          0.0                      0.0                           0.0
                INHAL.            0.2554E-04               1.74                          2.51
                INGEST.           0.1442E-02              98.26                          0.04
                  VEGET.          0.7273E-03            * 49.57                       *  0.02
                  MEAT            0.2664E-03            * 18.16                       *  0.01
                  MILK            0.4464E-03            * 30.43                       *  0.01
                PERCENT OF KIDNEYS  DOSE BY EACH PATHWAY

NUCLIDE         PATHWAY         DOSE(MAN-REMS)       PERCENT OF TOTAL     PERCENT OF DOSE FROM ALL NUCLIDES

RA-226          SUBM AIR          0.6070E-09               0.00                      99.69
                SURFACE           0.4982E-03               0.04                      67.43
                SWIMMING          0.3051E-06               0.00                      89.34
                INHAL.            0.1168E-03               0.01                       2.24
                INGEST.           0.1247E 01              99.95                       7.98
                  VEGET.          0.1149E 01            * 92.07                     *  7.35
                  MEAT            0.7962E-01            *  6.38                     *  0.51
                  MILK            0.1866E-01            *  1.50                     *  0.12
PB-210          SUBM AIR          0.0                      0.0                        0.0
                SURFACE           0.2402E-03               0.12                      32.51
                SWIMMING          0.3607E-07               0.00                      10.56
                INHAL.            0.0                      0.0                        0.0
                INGEST.           0.2071E 00              99.88                       1.33
                  VEGET.          0.1701E 00            * 82.03                     *  1.09
                  MEAT            0.3278E-01            * 15.81                     *  0.21
                  MILK            0.4255E-02            *  2.05                     *  0.03
PO-210          SUBM AIR          0.1867E-11               0.00                       0.31
                SURFACE           0.4559E-06               0.00                       0.06
                SWIMMING          0.3313E-09               0.00                       0.10
                INHAL.            0.5083E-02               0.04                      97.26
                INGEST.           0.1418E 02              99.96                      90.69
                  VEGET.          0.1222E 02            * 86.13                     * 78.14
                  MEAT            0.1887E 01            * 13.31                     * 12.07
                  MILK            0.7385E-01            *  0.52                     *  0.47
RN-222          SUBM AIR          0.0                      0.0                        0.0
                SURFACE           0.0                      0.0                        0.0
                SWIMMING          0.0                      0.0                        0.0
                INHAL.            0.0                      0.0                        0.0
                INGEST.           0.0                      0.0                        0.0
                  VEGET.          0.0                   *  0.0                      *  0.0
                  MEAT            0.0                   *  0.0                      *  0.0
                  MILK            0.0                   *  0.0                      *  0.0
H-3             SUBM AIR          0.0                      0.0                        0.0
                SURFACE           0.0                      0.0                        0.0
                SWIMMING          0.0                      0.0                        0.0
                INHAL.            0.2657E-04               1.81                       0.51
                INGEST.           0.1442E-02              98.19                       0.01
                  VEGET.          0.7273E-03            * 49.54                     *  0.00
                  MEAT            0.2664E-03            * 18.15                     *  0.00
                  MILK            0.4464E-03            * 30.41                     *  0.00
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                    PERCENT OF TESTES   DOSE BY EACH PATHWAY

NUCLIDE         PATHWAY        DOSE(MAN-REMS)       PERCENT OF TOTAL    PERCENT OF DOSE FROM ALL NUCLIDES

RA-226          SUBM AIR        0.1025E-08               0.00                      99.81
                SURFACE         0.8413E-03               0.07                      69.38
                SWIMMING        0.5153E-06               0.00                      90.19
                INHAL.          0.1172E-03               0.01                      27.48
                INGEST.         0.1249E 01              99.92                      61.08
                  VEGET.        0.1151E 01             * 92.05                   * 56.27
                  MEAT          0.7976E-01             *  6.38                   *  3.90
                  MILK          0.1869E-01             *  1.49                   *  0.91
PB-210          SUBM AIR        0.0                      0.0                        0.0
                SURFACE         0.3708E-03              15.18                      30.58
                SWIMMING        0.5568E-07               0.00                       9.75
                INHAL.          0.0                      0.0                        0.0
                INGEST.         0.2071E-02              84.82                       0.10
                  VEGET.        0.1701E-02             * 69.65                   *  0.08
                  MEAT          0.3278E-03             * 13.42                   *  0.02
                  MILK          0.4255E-04             *  1.74                   *  0.00
PO-210          SUBM AIR        0.1975E-11               0.00                       0.19
                SURFACE         0.4822E-06               0.00                       0.04
                SWIMMING        0.3505E-09               0.00                       0.06
                INHAL.          0.2834E-03               0.04                      66.48
                INGEST.         0.7925E 00              99.96                      38.75
                  VEGET.        0.6829E 00             * 86.13                   * 33.39
                  MEAT          0.1055E 00             * 13.31                   *  5.16
                  MILK          0.4128E-02             *  0.52                   *  0.20
RN-222          SUBM AIR        0.0                      0.0                        0.0
                SURFACE         0.0                      0.0                        0.0
                SWIMMING        0.0                      0.0                        0.0
                INHAL.          0.0                      0.0                        0.0
                INGEST.         0.0                      0.0                        0.0
                  VEGET.        0.0                    *  0.0                    *  0.0
                  MEAT          0.0                    *  0.0                    *  0.0
                  MILK          0.0                    *  0.0                    *  0.0
H-3             SUBM AIR        0.0                      0.0                        0.0
                SURFACE         0.0                      0.0                        0.0
                SWIMMING        0.0                      0.0                        0.0
                INHAL.          0.2575E-04               1.75                       6.04
                INGEST.         0.1442E-02              98.25                       0.07
                  VEGET.        0.7273E-03             * 49.56                   *  0.04
                  MEAT          0.2664E-03             * 18.16                   *  0.01
                  MILK          0.4464E-03             * 30.42                   *  0.02
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             PERCENT OF OVARIES  DOSE BY EACH PATHWAY

NUCLIDE       PATHWAY        DOSE(MAN-REMS)      PERCENT OF TOTAL    PERCENT OF DOSE FROM ALL NUCLIDES


RA-226        SUBM AIR         0.4402E-09              0.00                        99.76
              SURFACE          0.3613E-03              0.03                        62.21
              SWIMMING         0.2213E-06              0.00                        86.99
              INHAL.           0.1172E-03              0.01                        27.50
              INGEST.          0.1251E 01             99.96                        61.12
                VEGET.         0.1153E 01           * 92.08                      * 56.30
                MEAT           0.7989E-01           *  6.38                      *  3.90
                MILK           0.1872E-01           *  1.50                      *  0.91
PB-210        SUBM AIR         0.0                     0.0                          0.0
              SURFACE          0.2192E-03              9.57                        37.75
              SWIMMING         0.3292E-07              0.00                        12.94
              INHAL.           0.0                     0.0                          0.0
              INGEST.          0.2071E-02             90.43                         0.10
                VEGET.         0.1701E-02           * 74.26                      *  0.08
                MEAT           0.3278E-03           * 14.31                      *  0.02
                MILK           0.4255E-04           *  1.86                      *  0.00
PO-210        SUBM AIR         0.1047E-11              0.00                         0.24
              SURFACE          0.2556E-06              0.00                         0.04
              SWIMMING         0.1858E-09              0.00                         0.07
              INHAL.           0.2834E-03              0.04                        66.51
              INGEST.          0.7925E 00             99.96                        38.71
                VEGET.         0.6829E 00           * 86.13                      * 33.35
                MEAT           0.1055E 00           * 13.31                      *  5.15
                MILK           0.4128E-02           *  0.52                      *  0.20
RN-222        SUBM AIR         0.0                     0.0                          0.0
              SURFACE          0.0                     0.0                          0.0
              SWIMMING         0.0                     0.0                          0.0
              INHAL.           0.0                     0.0                          0.0
              INGEST.          0.0                     0.0                          0.0
                VEGET.         0.0                  *  0.0                       *  0.0
                MEAT           0.0                  *  0.0                       *  0.0
                MILK           0.0                  *  0.0                       *  0.0
H-3           SUBM AIR         0.0                     0.0                          0.0
              SURFACE          0.0                     0.0                          0.0
              SWIMMING         0.0                     0.0                          0.0
              INHAL.           0.2554E-04              1.74                         5.99
              INGEST.          0.1442E-02             98.26                         0.07
                VEGET.         0.7273E-03           * 49.57                      *  0.04
                MEAT           0.2664E-03           * 18.16                      *  0.01
                MILK           0.4464E-03           * 30.43                      *  0.02
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                         CONTRIBUTION OF EXPOSURE MODES TO TOT.BODY DOSES
EXPOSURE MODE                   ANNUAL DOSE(MAN-REMS)                PERCENT OF TOTAL DOSE
  SUBM AIR                        0.8421E-09                                  0.0000
  SURFACE                         0.1107E-02                                  0.0066
  SWIMMING                        0.4852E-06                                  0.0000
  INHAL.                          0.2166E-02                                  0.0130
  INGEST.                         0.1670E 02                                 99.9804
    VEGET.                       *0.1529E 02                             *   91.4937
    MEAT                         *0.1173E 01                             *    7.0218
    MILK                         *0.2448E 00                             *    1.4651
                         CONTRIBUTION OF EXPOSURE MODES TO R MAR    DOSES
EXPOSURE MODE                   ANNUAL DOSE(MAN-REMS)                PERCENT OF TOTAL DOSE
  SUBM AIR                        0.1208E-08                                  0.0000
  SURFACE                         0.1646E-02                                  0.0361
  SWIMMING                        0.7051E-06                                  0.0000
  INHAL.                          0.6662E-03                                  0.0146
  INGEST.                         0.4556E 01                                 99.9492
    VEGET.                       *0.4136E 01                             *   90.7460
    MEAT                         *0.3586E 00                             *    7.8670
    MILK                         *0.6091E-01                             *    1.3362
                         CONTRIBUTION OF EXPOSURE MODES TO LUNGS    DOSES
EXPOSURE MODE                   ANNUAL DOSE(MAN-REMS)                PERCENT OF TOTAL DOSE
  SUBM AIR                        0.7425E-09                                  0.0000
  SURFACE                         0.8804E-03                                  3.0940
  SWIMMING                        0.4135E-06                                  0.0015
  INHAL.                          0.2602E-01                                 91.4422
  INGEST.                         0.1554E-02                                  5.4624
    VEGET.                       *0.8308E-03                             *    2.9195
    MEAT                         *0.2740E-03                             *    0.9629
    MILK                         *0.4481E-03                             *    1.5748
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                        CONTRIBUTION OF EXPOSURE MODES TO ENDOST   DOSES
EXPOSURE MODE                   ANNUAL DOSE(MAN-REMS)                  PERCENT OF TOTAL DOSE
  SUBM AIR                          0.1399E-08                                 0.0000
  SURFACE                           0.2018E-02                                 0.0103
  SWIMMING                          0.8333E-06                                 0.0000
  INHAL.                            0.1899E-02                                 0.0097
  INGEST.                           0.1967E 02                                99.9801
    VEGET.                         *0.1803E 02                            *   91.6523
    MEAT                           *0.1344E 01                            *    6.8297
    MILK                           *0.2948E 00                            *    1.4983
                        CONTRIBUTION OF EXPOSURE MODES TO S WALL   DOSES
EXPOSURE MODE                   ANNUAL DOSE(MAN-REMS)                  PERCENT OF TOTAL DOSE
  SUBM AIR                          0.5495E-09                                 0.0000
  SURFACE                           0.6809E-C3                                 3.7193
  SWIMMING                          0.3103E-06                                 0.0017
  INHAL.                            0.2701E-04                                 0.1475
  INGEST.                           0.1760E-01                                96.1314
    VEGET.                         *0.1520E-01                            *   83.0211
    MEAT                           *0.1778E-02                            *    9.7107
    MILK                           *0.6209E-03                            *    3.3916
                        CONTRIBUTION OF EXPOSURE MODES TO LLI WALL DOSES
EXPOSURE MODE                   ANNUAL DOSE(MAN-REMS)                  PERCENT OF TOTAL DOSE
  SUBM AIR                          0.4606E-09                                 0.0000
  SURFACE                           0.5087E-03                                 0.0519
  SWIMMING                          0.2508E-06                                 0.0000
  INHAL.                            0.9001E-04                                 0.0092
  INGEST.                           0.9790E 00                                99.9388
    VEGET.                         *0.8849E 00                            *   90.3329
    MEAT                           *0.8167E-01                            *    8.3376
    MILK                           *0.1242E-01                            *    1.2682
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                              CONTRIBUTION OF EXPOSURE MODES TO THYROID  DOSES
EXPOSURE MODE                         ANNUAL DOSE(MAN-REMS)                      PERCENT OF TOTAL DOSE
  SUBM AIR                                0.8397E-09                                       0.0000
  SURFACE                                 0.1093E-02                                       0.0534
  SWIMMING                                0.4824E-06                                       0.0000
  INHAL.                                  0.4261E-03                                       0.0208
  INGEST.                                 0.2045E 01                                      99.9258
    VEGET.                               *0.1836E 01                                 *    89.7065
    MEAT                                 *0.1859E 00                                 *     9.0806
    MILK                                 *0.2331E-01                                 *     1.1387
                              CONTRIBUTION OF EXPOSURE MODES TO LIVER    DOSES
EXPOSURE MODE                         ANNUAL DOSE(MAN-REMS)                      PERCENT OF TOTAL DOSE
  SUBM AIR                                0.6419E-09                                       0.0000
  SURFACE                                 0.7427E-03                                       0.0196
  SWIMMING                                0.3547E-06                                       0.0000
  INHAL.                                  0.1018E-02                                       0.0268
  INGEST.                                 0.3796E 01                                      99.9536
    VEGET.                               *0.3341E 01                                 *    87.9624
    MEAT                                 *0.4215E 00                                 *    11.0990
    MILK                                 *0.3388E-01                                 *     0.8922
                              CONTRIBUTION OF EXPOSURE MODES TO KIDNEYS  DOSES
EXPOSURE MODE                         ANNUAL DOSE(MAN-REMS)                      PERCENT OF TOTAL DOSE
  SUBM AIR                                0.6088E-09                                       0.0000
  SURFACE                                 0.7389E-03                                       0.0047
  SWIMMING                                0.3415E-06                                       0.0000
  INHAL.                                  0.5226E-02                                       0.0334
  INGEST.                                 0.1563E 02                                      99.9619
    VEGET.                               *0.1354E 02                                 *    86.5506
    MEAT                                 *0.2000E 01                                 *    12.7895
    MILK                                 *0.9721E-01                                 *     0.6216
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                   CONTRIBUTION OF EXPOSURE MODES TO TESTES   DOSES
EXPOSURE MODE                ANNUAL DOSE(MAN-REMS)                 PERCENT OF TOTAL DOSE
  SUBM AIR                       0.1027E-08                                0.0000
  SURFACE                        0.1213E-02                                0.0592
  SWIMMING                       0.5713E-06                                0.0000
  INHAL.                         0.4264E-03                                0.0208
  INGEST.                        0.2045E 01                               99.9199
     VEGET.                     *0.1836E 01                          *    89.7012
     MEAT                       *0.1859E 00                          *     9.0800
     MILK                       *0.2331E-01                          *     1.1386
                   CONTRIBUTION OF EXPOSURE MODES TO OVARIES  DOSES
EXPOSURE MODE                ANNUAL DOSE(MAN-REMS)                 PERCENT OF TOTAL DOSE
  SUBM AIR                       0.4412E-09                                0.0000
  SURFACE                        0.5807E-03                                0.0284
  SWIMMING                       0.2544E-06                                0.0000
  INHAL.                         0.4261E-03                                0.0208
  INGEST.                        0.2047E 01                               99.9508
     VEGET.                     *0.1838E 01                          *    89.7314
     MEAT                       *0.1860E 00                          *     9.0801
     MILK                       *0.2334E-01                          *     1.1393
     TOTAL DOSE TO EACH ORGAN THROUGH ALL PATHWAYS

 ORGAN                                     DOSE(MAN-REMS)

TOT.BODY                                     0.1671E 02

R MAR                                        0.4558E 01

LUNGS                                        0.2846E-01

ENDOST                                       0.1968E 02

S WALL                                       0.1831E-01

LLI WALL                                     0.9796E 00

THYROID                                      0.2047E 01

LIVER                                        0.3798E 01

KIDNEYS                                      0.1564E 02

TESTES                                       0.2047E 01

OVARIES                                      0.2048E 01
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                                     CONTRIBUTORS TO ORGAN DOSES

                                                                         PERCENT

NUCLIDE    TOT.BODY   R MAR      LUNGS      ENDOST     S WALL     LLI WALL   THYROID    LIVER      KIDNEYS    TESTES     OVARIES

RA-226      91.8693    79.3290    37.0638    94.7674    52.9205    71.8967    61.0738    32.8553     7.9786    61.0778    61.1133
PB-210       3.0019     2.1441     0.9700     3.3538     1.3320     0.1551     0.1210     2.5978     1.3261     0.1193     0.1118
PO-210       5.1202    18.4947    56.8097     1.8715    37.7318    27.7983    38.7335    64.5082    90.6859    38.7313    38.7033
RN-222       0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
H-3          0.0088     0.0322     5.1564     0.0074     8.0157     0.1500     0.0717     0.0386     0.0094     0.0717     0.0716
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          ANNUAL POPULATION DOSES(MAN-REMS)
NUCLIDE              ORGAN              DOSE
 RA-226             TOT.BODY          0.1535E 02
 RA-226             R MAR             0.3616E 01
 RA-226             LUNGS             0.1055E-01
 RA-226             ENDOST            0.1865E 02
 RA-226             S WALL            0.9687E-02
 RA-226             LLI WALL          0.7043E 00
 RA-226             THYROID           0.1250E 01
 RA-226             LIVER             0.1248E 01
 RA-226             KIDNEYS           0.1248E 01
 RA-226             TESTES            0.1250E 01
 RA-226             OVARIES           0.1252E 01
 PB-210             TOT.BODY          0.5015E 00
 PB-210             R MAR             0.9773E-01
 PB-210             LUNGS             0.2760E-03
 PB-210             ENDOST            0.6599E 00
 PB-210             S WALL            0.2438E-03
 PB-210             LLI WALL          0.1519E-02
 PB-210             THYROID           0.2476E-02
 PB-210             LIVER             0.9866E-01
 PB-210             KIDNEYS           0.2074E 00
 PB-210             TESTES            0.2442E-02
 PB-210             OVARIES           0.2291E-02
 PO-210             TOT.BODY          0.8554E 00
 PO-210             R MAR             0.8430E 00
 PO-210             LUNGS             0.1617E-01
 PO-210             ENDOST            0.3682E 00
 PO-210             S WALL            0.6907E-02
 PO-210             LLI WALL          0.2723E 00
 PO-210             THYROID           0.7928E 00
 PO-210             LIVER             0.2450E 01
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PO-210          KIDNEYS         0.1418E 02
PO-210          TESTES          0.7928E 00
PO-210          OVARIES         0.7928E 00
RN-222          TOT.BODY        0.0
RN-222          R MAR           0.0
RN-222          LUNGS           0.0
RN-222          ENDOST          0.0
RN-222          S WALL          0.0
RN-222          LLI WALL        0.0
RN-222          THYROID         0.0
RN-222          LIVER           0.0
RN-222          KIDNEYS         0.0
RN-222          TESTES          0.0
RN-222          OVARIES         0.0
H-3             TOT.BODY        0.1467E-02
H-3             R MAR           0.1467E-02
H-3             LUNGS           0.1467E-02
H-3             ENDOST          0.1462E-02
H-3             S WALL          0.1467E-02
H-3             LLI WALL        0.1469E-02
H-3             THYROID         0.1467E-02
H-3             LIVER           0.1467E-02
H-3             KIDNEYS         0.1468E-02
H-3             TESTES          0.1467E-02
H-3             OVARIES         0.1467E-02
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WORKING LEVELS FOR RN-222 AND ITS SHORT-LIFE PROGENY AT VARIOUS LOCATIONS IN THE ENVIRONMENT
(FRACTION OF EQUILIBRIUM ASSUMED FOR WORKING LEVEL CALCULATIONS=0.700)

AREA		WORKING LEVEL (POPULATION)
WIND TOWARD	DISTANCE (METERS)	
1	1207	0.0
1	2414	0.0
1	4023	0.0
1	5632	0.0
1	7241	0.0
1	12068	0.779E-06
1	20113	0.0
1	32180	0.0
1	48270	0.198E-07
1	64360	0.851E-06
1	80450	0.490E-05
2	1207	0.0
2	2414	0.0
2	4023	0.0
2	5632	0.0
2	7241	0.0
2	12068	0.0
2	20113	0.196E-05
2	32180	0.523E-06
2	48270	0.146E-05
2	64360	0.494E-06
2	80450	0.345E-06
3	1207	0.0
3	2414	0.0
3	4023	0.0
3	5632	0.0
3	7241	0.0
3	12068	0.0
3	20113	0.0
3	32180	0.0
3	48270	0.406E-05
3	64360	0.383E-05
3	80450	0.124E-05
4	1207	0.0
4	2414	0.0
4	4023	0.0
4	5632	0.0
4	7241	0.0
4	12068	0.0
4	20113	0.136E-05
4	32180	0.104E-05
4	48270	0.160E-05
4	64360	0.986E-05
4	80450	0.124E-04
5	1207	0.0
5	2414	0.0
5	4023	0.0
5	5632	0.0
5	7241	0.0
5	12068	0.119E-05
5	20113	0.132E-05
5	32180	0.0

```
 5       48270              0.186E-06
 5       64360              0.114E-06
 5       80450              0.522E-05
 6        1207              0.0
 6        2414              0.181E-04
 6        4023              0.0
 6        5632              0.0
 6        72                0.0
 6       12068              0.0
 6       20113              0.0
 6       32180              0.525E-06
 6       48270              0.348E-06
 6       64360              0.755E-05
 6       80450              0.535E-05
 7        1207              0.0
 7        2414              0.0
 7        4023              0.0
 7        5632              0.0
 7        7241              0.0
 7       12068              0.0
 7       20113              0.0
 7       32180              0.157E-05
 7       48270              0.572E-06
 7       64360              0.195E-05
 7       80450              0.157E-06
 8        1207              0.0
 8        2414              0.0
 8        4023              0.0
 8        5632              0.0
 8        7241              0.0
 8       12068              0.0
 8       20113              0.266E-05
 8       32180              0.273E-05
 8       48270              0.816E-06
 8       64360              0.424E-06
 8       80450              0.0
 9        1207              0.0
 9        2414              0.0
 9        4023              0.0
 9        5632              0.0
 9        7241              0.0
 9       12068              0.0
 9       20113              0.0
 9       32180              0.179E-04
 9       48270              0.0
 9       64360              0.911E-06
 9       80450              0.0
10        1207              0.0
10        2414              0.0
10        4023              0.0
10        5632              0.0
10        7241              0.0
10       12068              0.163E-04
10       20113              0.0
10       32180              0.333E-05
10       48270              0.971E-06
10       64360              0.503E-06
10       80450              0.503E-06
11        1207              0.0
11        2414              0.0
11        4023              0.0
11        5632              0.0
11        7241              0.0
11       12068              0.107E-04
11       20113              0.962E-06
11       32180              0.0
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      11          48270                              0.847E-06
      11          64360                              0.427E-06
      11          80450                              0.767E-08
      12           1207                              0.0
      12           2414                              0.0
      12           4023                              0.0
      12           5632                              0.0
      12           7241                              0.0
      12          12068                              0.0
      12          20113                              0.226E-05
      12          32180                              0.0
      12          48270                              0.898E-06
      12          64360                              0.252E-06
      12          80450                              0.324E-06
      13           1207                              0.0
      13           2414                              0.0
      13           4023                              0.0
      13           5632                              0.0
      13           7241                              0.0
      13          12068                              0.0
      13          20113                              0.296E-06
      13          32180                              0.0
      13          48270                              0.847E-07
      13          64360                              0.399E-07
      13          80450                              0.584E-06
      14           1207                              0.0
      14           2414                              0.0
      14           4023                              0.0
      14           5632                              0.0
      14           7241                              0.0
      14          12068                              0.0
      14          20113                              0.0
      14          32180                              0.260E-06
      14          48270                              0.138E-06
      14          64360                              0.967E-06
      14          80450                              0.179E-05
      15           1207                              0.0
      15           2414                              0.0
      15           4023                              0.0
      15           5632                              0.0
      15           7241                              0.0
      15          12068                              0.0
      15          20113                              0.0
      15          32180                              0.0
      15          48270                              0.149E-06
      15          64360                              0.254E-06
      15          80450                              0.118E-05
      16           1207                              0.0
      16           2414                              0.0
      16           4023                              0.0
      16           5632                              0.325E-05
      16           7241                              0.0
      16          12068                              0.0
      16          20113                              0.0
      16          32180                              0.0
      16          48270                              0.984E-07
      16          64360                              0.267E-06
      16          80450                              0.471E-05
 COLLECTIVE WORKING LEVEL=  0.168E-03
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